UNITED NATIONS NATIONS UNIES

UNITED NATIONS MONITORING, VERIFICATION AND INSPECTION COMMISSION
(UNMOVIC)

Compendium

Observations and Lessons Learned

CHAPTER VIII

OBSERVATIONS AND LESSONS LEARNED

Introduction

The UNSCOM and UNMOVIC inspection process mandated under the Security Council has been a unique inspection regime. The mandate resulted from the conclusion of military conflict supported by the members of the Security Council in 1991 under Chapter VII of the UN Charter as an enforcement measure. As a result, many of the lessons learned which are listed below, may not be applicable to future monitoring or inspection regimes and should be viewed in the context in which they occurred. Certainly the underlying inspection powers and authority of the UN Commission to go anywhere at anytime and inspect anything deemed relevant, is unlikely to be a blue print for future inspections.

The weapons related part of the UN mandate for Iraq had two components, disarmament and monitoring. Disarmament assumes the existence of proscribed weapons and/or capabilities, which must be located, accounted for and, eventually destroyed, removed or rendered harmless. The monitoring and verification system's goal is to verify that dual-use legitimate activities are not diverted to proscribed activities. It was observed in Iraq, that the mere presence of a stringent on site inspection regime can, in itself, be a deterrent to such activities.

UN experience has shown that actions to achieve disarmament and actions to support a monitoring and verification system can be mutually supportive. There are many similarities and complementarities between these two activities and this was reflected in the recommendations of the Amorim Panel following the termination of inspections by the UN Special Commission in 1998. Both can be achieved, in an integrated fashion, through the use of on- site inspections with full access, including no-notice inspections.

1. The Environment of UN inspections in Iraq

Efforts to promote the non-proliferation of WMD and disarmament should contain some over arching elements. Among these are; (i) international policies: in the areas of security to create an environment where there is no perceived need for an individual state to acquire WMD, (ii) treaties: whereby countries commit to not acquire, develop, produce, stock-pile or use WMD, (iii) inspection and monitoring programmes: to create confidence that no acquisition, development, production, stock-pile or use of WMD occur, and (iv) export and import controls: to control or monitor the transfer of dual-use items so as to restrict the potential proliferation of WMD. These elements may be supplemented by other economic, political or military pressures.

In the case of Iraq, the regional policies to abstain from developing a WMD capability were absent during the 1970s and 1980s. The Middle East was a turbulent region for

much of the twentieth century and continues to be today fueled by wider suspicions of WMD possession, capabilities and motives. The suspicion that Israel and Iran possessed WMD was cited by Iraq as a motive for embarking upon its own WMD programmes.

By 1980, Israel, Syria, Egypt, Iran and Iraq were all signatory countries to the *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 of 1925. Although by 1980, many countries in the Middle East region had signed and ratified the Biological and Toxin Weapons Convention (BWC) of 1972, Israel had neither signed nor ratified the BWC while Egypt, Syria and the United Arab Emirates had signed but not ratified the Convention. During the early 1980s there were no international agreements controlling the trade in dual-use equipment and materials.

The environment in the Middle East region throughout much of the second half of the twentieth century was one of hostility between Israel and its Arab neighbours while conflict between Iraq and Iran lasted almost a decade. In such an environment, countries were suspicious of each other's intentions and being a signatory to an international convention was secondary to regime survival. Probably few countries were assured that others would abide by the international conventions relating to WMD.

It was in this environment that Iraq began its WMD programmes and it was also in a similar environment that following the 1991 Gulf War that the UN Special Commission along with the IAEA were given responsibility for WMD-related inspections.

2. Package for disarming Iraq

Despite some skepticism from many areas within the international community, in hindsight, it has now become clear that the UN inspection system in Iraq was indeed successful to a large degree, in fulfilling its disarmament and monitoring obligations. Crucial to the inspection system was the underlying backing of military, political, and economic pressure particularly from the permanent members of the Security Council. While it will be for others to judge the level success or shortcomings from the UN inspections regime in Iraq, it seems clear that without such international pressure, even limited success was not assured.

Over time, issues arose with regard to Iraq in general and the inspection process in particular on which each Security Council member formed its own and different position from others. Iraq was well aware of the difficulty of dealing with a unified Security Council and tried to take advantage when opportunities arose, of the fractured opinion within the Council. At times this led to a more active role by the Secretary-General of the UN.

It was generally assumed by many Security Council members and UN inspectors themselves that the work of the Special Commission would be finite and short-term perhaps not lasting more than one year. Success would have been measured by the termination of the organisation itself after completing its mandate. Through many

changing circumstances and international developments, the on-site inspection process lasted much longer than envisaged (UNSCOM 1991 to 1998 and UNMOVIC 2002 to 2003), with many controversial issues being debated especially in relation to what degree Iraq was disarmed of WMD.

The obligations expressed in Security Council resolution 687 (1991) were drafted to encompass a broad sphere, open to wide interpretation. The lack of specifics in the resolution led to controversy, debate, division and uncertainty and open to challenge by Iraq. The "go anywhere at anytime" aspect of the mandate seemed impressive and beyond challenge, but including "respecting the rights and sovereignty of the Iraqi state" gave rise to at least the perception of some limits to the inspection process. Iraq challenged inspections to "sensitive sites", protested at inspections to some military and intelligence and security apparatus facilities, denied access to certain Presidential sites and raised questions at inspections of non-government sites. Iraqi protests at least superficially, appeared to reflect some legitimate concerns. Also as the mandate was focused on WMD-related issues, this too became a bone of contention when inspectors wanted to inspect sites containing conventional munitions.

Although establishing a mandate with very specific clauses may also have limitations and drawbacks, any mandate that is vague or open to interpretation also has its own set of problems. The initial resolution 687 (1991) was added to and supplemented through the 1990's by many other resolutions to overcome problems as they arose.

Although the UN mandate arose from a Security Council resolution, it was premised upon total and complete cooperation by the Iraqi authorities. This implied that Iraq would declare and the UN would inspect, verify and where necessary destroy, render harmless or remove any WMD or related materials, equipment and infrastructure. However, from 1991 until 1995 Iraqi cooperation was particularly uneven. During the mid-1990s, Iraq admitted a programme of concealment, deception and denial in all programmes but especially so in the biological area. In addition, Iraq embarked on a policy of unilateral destruction of missiles, chemical and biological weapons, bulk agents and precursors, supporting documentation and relevant information that in essence meant that full accountability and verification would not be possible.

When the inspection process began, it did so with little trust established between the inspectors and Iraq. The lack of total cooperation by Iraq even during the initial inspections in 1991 encouraged further suspicion about the accuracy and completeness of declarations, statements, interviews and documents submitted by Iraq. Not only was it more difficult for Iraq to convince UN inspectors that they were telling the truth but it caused the UN inspectors, particularly in the biological area, to change their *modus operandi* from one of verification of declarations to one of investigation and forensic analysis. With false and misleading information being supplied by Iraq particularly during the early years of the inspection process, it became almost impossible for Iraq to provide convincing evidence that would remove doubt that even more evidence remained undisclosed. While Iraq's actions led to mistrust by UN inspectors, the mistrust became a two way street.

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CHAPTER VIII

From its inception, the UN inspection system in Iraq grew, developed and adapted to changing circumstances by "learning on the job". In its early years, UNSCOM had full support from the Security Council members. Some member states were very generous in their supply of experienced inspectors, material, equipment and support to the Special Commission. From 1991 to 1996, UNSCOM was reliant on contributions from UN member states as well as a portion of frozen Iraqi financial assets given to the UN, to finance its operations. The close cooperation/connection and assistance by some member states led to the strong perception that the Special Commission was not totally independent and in fact was compromised and under the influence of the US and perhaps to a lesser degree the UK.

Iraq also had its suspicions and concerns. Iraq stated that the Special Commission was heavily influenced by a few member states and that the Commission was more concerned with collecting intelligence and data (perhaps to be used for hostile purposes) than disarming and monitoring. Iraq protested several times prior to 1999, about the inspection process and banned inspectors of US nationality for a period of time. Cooperation by Iraq with the UN Special Commission inspection teams varied. Despite the actions of high-level delegations, Iraq often stated that whatever they did UN inspectors would want more and that the inspection process was just a means to prolong economic sanctions indefinitely and so keep Iraq contained and down. So not only was there mistrust by the UN inspectors of the information supplied by Iraq but also mutual mistrust by Iraq of the role and purpose of the inspections themselves.

Following the end of inspections in Iraq in 1998 by UNSCOM, the Amorim panel recommended a new fully independent inspection organisation, and also recommended combining the tasks of disarmament and monitoring into a new system of reinforced monitoring. The changes in organizational structure between UNSCOM and UNMOVIC reflect the lessons learned by the Security Council up to that point.

From the time of Lt. General Hussein Kamel's[1] defection to Jordan in 1995, until the replacement of the UN Special Commission in 1999, UN inspectors were more questioning of information provided by Iraq and increasingly the onus was placed on Iraq to prove that it did not have any remaining weapons systems, bulk agents or other proscribed materials. Aside from the organizational and procedural changes that may have occurred with the creation of UNMOVIC, Iraq was still placed in a position of trying to prove the negative. For any country subject to inspections, trying to prove the negative is very difficult and in many cases is a mission impossible.

Iraq's case was very different from that of both South Africa and Libya that admitted past WMD programmes to the international community and invited inspections aimed at verification. Unlike Iraq, inspections in those countries proceeded without incident and their respective declarations were accepted.

[1] He was the son-in-law of the President and Head of the Military Industrialisation Commission (MIC)

Key Lessons

1. A prerequisite for an effective UN inspection regime is cohesion among and support from the permanent members of the Security Council for such a system. It is always preferable to establish an inspection regime in an atmosphere of cooperation (as for instance with the IAEA, OPCW or WHO) rather than under the threat of military action (as for UNSCOM and UNMOVIC). Either way, however, the support for inspections must be backed by the necessary military, economic and political pressures. Any fracturing of unity or weakening of resolve by permanent members is likely to result in this perceived weakness being exploited by the inspected body.
2. Even with unity and military backing there is still a reliance on the host country to cooperate fully with the inspection agency. Failure to do so, in particular by resorting to unilateral destruction of evidence without supervision and registration by the inspection body, will create disharmony and promote mistrust between the inspectors and the inspected thus prolonging the inspection process.
3. The mandate for the inspection agency should be as specific as possible given the circumstances. It seems better to have a specific mandate that is adjusted according to circumstances rather than one that is open-ended, vague or with loose language that can and probably will be exploited by both sides.
4. Complete independence is a prerequisite for a UN inspection agency. The inspection agency must be independent as well as be seen to be totally independent. This is required to ally fears of misusing the inspection process either to support other agendas or to keep the inspected party in a permanent state of weakness.
5. Proving the negative is a recipe for enduring difficulties and unending inspections.

3. Results of UN activities

Within two months of the establishment of UNSCOM, remarkable progress was made; the first inspection team was in Iraq, an inspection regime was established and various inspection procedures were in place. By the time of the replacement of UNSCOM, a large number of chemical weapons and bulk agents were destroyed under its supervision. Missiles and related facilities were rendered harmless or destroyed, and abundant evidence for illicit biological activities was uncovered to place sufficient pressure on Iraq for it to reveal elements of its biological weapons programme. In addition, UNSCOM introduced an import/export mechanism that was very successful in the monitoring of imported dual-use items.

The verification system developed by UNSCOM was further expanded and transformed by the Security Council to UNMOVIC, with a reinforced system of ongoing monitoring and verification as recommended by the Amorim Panel.

The establishment of UNSCOM/UNMOVIC by the Security Council demonstrated that it was possible to develop a single comprehensive and credible verification system that covered multiple areas of WMD and delivery means.

The monitoring and verification system developed by the Security Council was instrumental in preventing a resumption of proscribed activities. During the period 1992-1993, Iraq attempted to conceal some ongoing proscribed missile projects. These projects were halted once the monitoring system under the Plan for On-going Monitoring and Verification (OMV) was established and became fully operational. Only during the period 1999 to 2002, when UN inspectors were absent from Iraq, did Iraq engage in proscribed missile activities. In addition, the system of ongoing monitoring and verification provided assurance that chemical weapon production had ended in 1991, and was a strong deterrent to the resumption of proscribed activities thereafter.

During interviews with Lt. General Hussein Kamel in Jordan and with other senior Iraqis who interacted with the UN inspectors, it was revealed that the inspection system was a deterrent to the resumption of proscribed activities.

Lesson

Inspection regimes can be effective provided that there is cooperation and consensus among Security Council members. The inspection regime can address disarmament, monitoring and verification through the use of the same - or similar - tools

Lesson

Despite much skepticism by some member states, the UN verification system was able to deter the resumption of proscribed activities by Iraq after 1991.

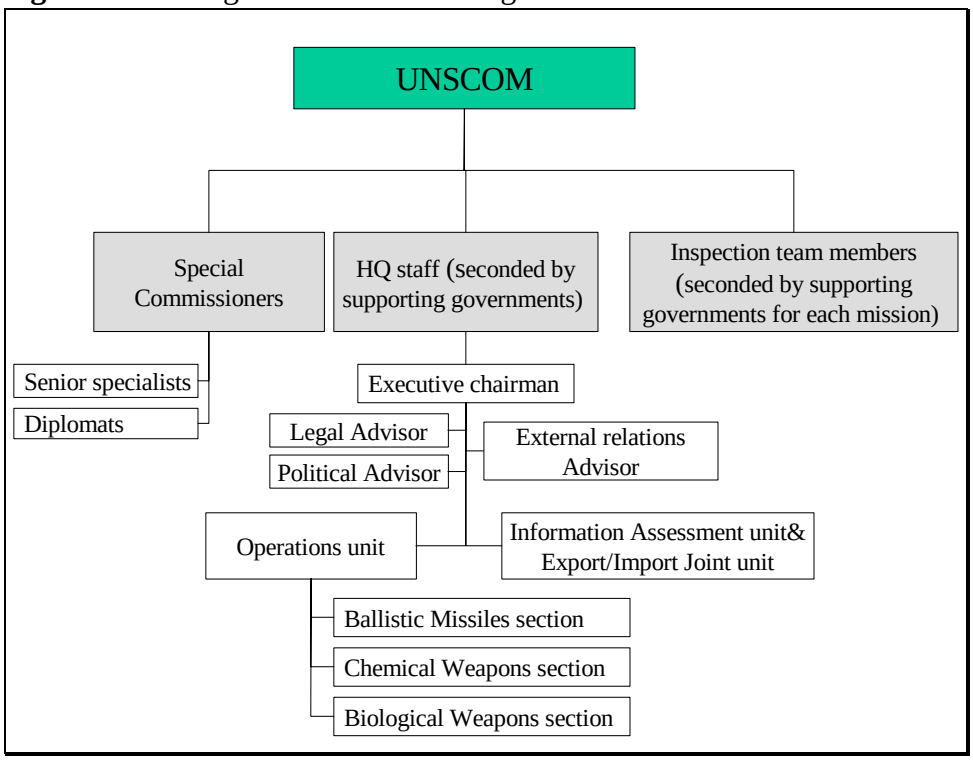
Lesson
Concealed and heavily guarded proscribed programmes or their elements could not be hidden in their entirety from an effective and comprehensive UN inspection and verification system.

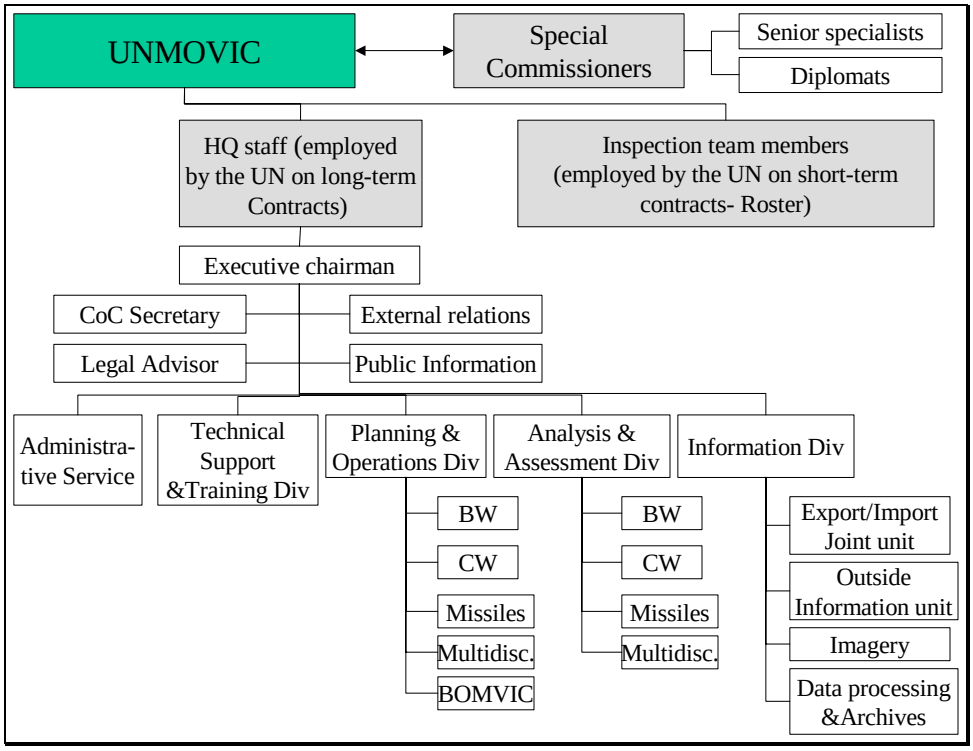
4. Organization of the UN Commission

The organisational structure of UNSCOM and UNMOVIC were different due to the difference in environment, time and that the experience gained during UNSCOM was transformed into UNMOVIC. Almost all of the UNSCOM staff at headquarters and inspection team members were seconded and paid for by national governments. A small council called “Special Commissioners” played an advisory role and was made up of senior specialists and diplomats. There was no appointment for section chiefs related to the chemical, missile or biological groups but rather by default the chief was based on seniority in time. The Operations unit was made up of one officer seconded by a member state and he coordinated missions and requirements.

Below in Figure VIII.I the respective organisations of UNSCOM and UNMOVIC are shown for illustrative purposes.

Figure VIII.I Organization and staffing of UNSCOM and UNMOVIC





The role of the Executive Chairman during UNSCOM/UNMOVIC differed slightly between the two inspection agencies with regard to inspection activities. With the Special Commission, the head of the field office in Baghdad as well as the various chief inspectors in the field, reported directly to the Executive Chairman. In the case of UNMOVIC, the reporting chain was altered with the Director of Planning and Operations responsible for all inspection activity including the activities in the Baghdad and Mosul field offices. The Director of Assessment and Analysis assumed responsibility for preparing technical reports for the Executive Chairman to deliver to the Security Council. UNSCOM's policy was to appoint chief inspectors for resident (monitoring) teams for from outside the headquarters staff in New York while, where possible to use headquarters staff as chief inspectors for the disarmament inspections. In the biological group however, there were more exceptions with non-headquarters staff appointed as chief inspectors for disarmament missions. The UNMOVIC policy was to appoint only headquarters staff as chief inspectors.

While UNSCOM and UNMOVIC differed in their organisational structures, both structures offered certain strengths and weaknesses. UNSCOM's small headquarters staff was responsible for both verification activities and assessment of their results. The positive side of this arrangement was that this staff had first hand knowledge of the inspection sites, and the issues that went on during the inspection process. The down side of this was that the same staff that was busy preparing for a number of intense inspections, particularly after 1994, had little time to absorb huge quantities of information from outside sources or the luxury of time to do in depth analysis on a range of issues. The lesson learned from this, and incorporated into the UNMOVIC structure, was to separate the functions of operations from analysis within the organizational structure of the verification and monitoring body.

UNMOVIC's concept was to establish two separate units: (1) the Division of Planning and Operations, that was responsible for planning, directing and performing all monitoring, verification and inspection activities (the Baghdad Ongoing Monitoring, Verification and Inspection Centre (BOMVIC) was directly subordinated to the Director of Planning and Operations), and (2) the Division of Analysis and Assessment, responsible for the analysis and assessment of information resulting from the organization's own activities in the field, as well as data from other sources, such as information on export/import activities, overhead imagery and outside information.

UNMOVIC's model of operations was to rotate staff through both branches so that operations staff would become familiar with the analysis problems and the use to which data was being put, and the analysis staff with experience in the field would be better able to judge the quality of data supplied. Although this was the theory implicit in UNMOVIC's structure, it had major shortcomings in practice. At the time when UNMOVIC was conducting inspections in Iraq, it was also preparing in-depth reports for the Executive Chairman to present to the Security Council. Both the fieldwork and the report preparations required experienced personnel to fulfil these tasks. Therefore instead of having a well-organised rotation of experts, there was a competition for limited

numbers of experienced personnel between the two branches. Over time this may have been resolved as roster personnel became more experienced and perhaps a staff rotation may have been possible however in the circumstances which existed at the time, a tug of war occurred for chief inspectors for the field and personnel required for analysis and report preparation.

Within the New York office, experts generally worked within their specific discipline with UNSCOM, whereas data was more freely shared across disciplines within UNMOVIC. Some differences between the two organizations are shown in Table VIII.I.

Table VIII.I Comparison UNSCOM and UNMOVIC

	UNSCOM	UNMOVIC
Reporting	Reported directly to the Security Council on a quarterly basis from 1991 to 1996 then every six months both via the Secretary General's Office.	Reported to the Security Council every quarter via the Secretary General's Office.
Oversight and guidance	Commissioners met bi-annually and were directly involved in missions plus general advice on policy.	A College of Commissioners met quarterly to review reports and provide advice and guidance on major policy issues.
Preparations	Inspections almost immediate in 1991.	Two years delay before inspection started gave time for preparation and training.
Staff	Non-UN staff seconded from Members States.	Employed by UN on fixed-term contracts.
Training	Short-term training of three days for CI's in Bahrain prior to mission. No training for others - "learning on the job".	Several weeks of training for all inspectors prior to deployment. Continued training of roster personnel.
Geographic spread	Main emphasis on expertise and geographic representation where possible.	Greater emphasis on geographic spread although expertise also emphasized.
Chief inspectors	Chief inspectors selected by the Executive Chairman from HQ or outside the organization.	Chief inspectors selected by the Director of Planning and Operations.
Organization	Operations and assessment were the same group of experts.	Separate Assessment and Analysis division from the Operations Division.
	Separate disciplines working through the Executive Chairman.	Flatter structure with more integrated approach between all disciplines.
	Lack of formal hierarchy enhanced integration of individual capabilities.	Emphasis on joint inspections and multidisciplinary teams.
	Executive Chairman held a daily meeting with all staff.	Executive Chairman held weekly meetings with senior staff and all staff as necessary.
	Chief inspectors reported directly to the Executive Chairman.	Chief inspectors reported directly to Director of Operations.
Export/Import mechanism	Established under the information unit.	The unit was expanded and formalized as a Division.

Capabilities	Sampling and analysis were supplied through external teams.	In-house sampling and analysis procedures, screening laboratory and network of reference laboratories were established.
	Equipment dependent on supporting Member states	Equipment procured and purchased as required to support all sampling and analysis.

The groundbreaking work in establishing quickly and operating an on-site inspection team was done by UNSCOM with strong support from member states. Much was learned on the job and UNSCOM adapted to the changing circumstances through time. UNMOVIC learned from its predecessor and had sufficient time to organize and train its inspectors before going into Iraq. Consequently, three main improvements were introduced: training, the analysis and assessment sections and a stronger emphasis on multidisciplinary inspections.

5. Governance. Advice, Guidance, and Oversight

When UNSCOM was established, a body of Commissioners who were nominated by member countries or appointed by the Secretary General supported it. The Commissioners were either technical experts or diplomats. Although Commissioners did not officially represent their respective country and were selected as individuals, inevitably most Commissioners echoed their country's political views.

The role of the Commissioners was to provide advice and input into the inspection process. Several of the UNSCOM Commissioners were inspectors in Iraq and were an integral part of UNSCOM field operations. In addition to meeting with the Executive Chairman, the Commissioners also met separately and informally as a group at the headquarters in New York and drafted a report to provide advice, guidance and suggestions to the Executive Chairman.

During UNMOVIC, as required by resolution 1284 (1999) the Secretary-General in consultation with the Executive Chairman, appointed suitably qualified experts to serve as a College of Commissioners. The Commissioners, chaired by the Executive Chairman met regularly to review the implementation of resolution 1284 (1999) and to provide advice and guidance on significant policy issues and on written reports to be submitted to the Security Council through the Secretary-General. In addition to the members of the College, the Executive Chairman invited the Director General of the IAEA and the Director-General of the OPCW to designate representatives to attend the meetings of the College as observers. Although the members of the College were appointed in their individual capacities and did not officially represent their governments, nevertheless individual College members expressed some national views and concerns.

Lesson
The concept of Commissioners or a College of Commissioners proved beneficial for both organizations. Besides the advice and guidance given to the UN inspection agencies, the College of Commissioners in itself was an important body as it allowed some Security

Council members, especially the permanent members, to be engaged in and comment on the UN inspection activities. It was an informal sounding board below the level of the Security Council itself.

6. Financing

Financing is a crucial element for any organisation and underpins the size, structure and activities performed. In his first report to the Security Council in October 1991, the Executive Chairman wrote, "Two problems of an administrative nature have faced the Commission from its inception…these are staffing and financing of the Special Commission". [2] Later in that report he wrote "the Special Commission remains without a formally approved budget, without guaranteed assurances of the availability of adequate financial resources and without posts for personnel except on a short-term basis". [3]

As UNSCOM was established without any formalised budget, much of the Executive Chairman's time, effort and energy were expended particularly by seeking funding from cooperating countries. In its early years, UNSCOM survived on donations from member states that were matched by liquidations from frozen Iraqi assets in the US. As a result, UNSCOM was forced to use staff, verification technology, equipment, transportation, logistics and mission support provided mainly by UN member states at no cost. In 1996, Iraq agreed to accept resolution 986 (1995) which allowed member states to buy Iraqi oil and to pay the proceeds from the sale into a UN ESCROW account. Payments from this account were used to fund:

1. Purchases of goods for humanitarian purposes
2. The Compensation Claims Committee
3. Administration of the Oil for Food Programme
4. UNSCOM's activities. A small portion (0.8%) of the oil sales revenue was allocated to cover UNSCOM's operating costs. This allocation allowed UNSCOM to pay for goods and services that had been provided on loan (such as the contracting of fixed and rotary wing aircraft) by member states.

After 1996 and the allocation of funding from the Council approved sale of oil, UNSCOM had greater financial independence. The resolution was reaffirmed every six months with oil sales ceilings being adjusted and eventually removed.

UNMOVIC assumed the financial legacy it inherited from UNSCOM. The Executive Chairman was required to submit annual budget estimates that were sent through the Secretary-General for approval. UNMOVIC was able to staff its positions and acquire most of its inspection assets and services through the established UN procedures. Ownership allowed UNMOVIC to train its inspectors in advance on the use of specific instruments and items of equipment which it had selected. At the same time, a limited number of unique instruments and materials such as ground penetrating radar technology

[2] United Nations Security Council Doc No S/23165 October 1991
[3] IBID Para 31.

and life-saving equipment were also provided by member states, as was the case with UNSCOM.

Lesson
An obvious lesson learned by both UNSCOM and UNMOVIC with regard to asset ownership was that acquisition of one's own verification technology and equipment was more advantageous than relying on the generosity of a few individual member states. However, ownership is a function of the budget and mandate so the level of the budget afforded to such items may already dictate the choice. By having an organic element as part of the inspection agency, there is less dependence on member states for assistance. A separate budget allocation also means there is no need to spend energy seeking funding from member states that even if granted, casts doubt over the independence of the organisation.

7. Staffing/employment policies

UNSCOM and UNMOVIC followed different principles when staffing the organisation. In order to avoid the potential controversy of accepting staff gratis from national governments, a lesson for UNMOVIC was to recruit the vast majority of its staff as UN staff employees. However, although the terms and conditions of employment were different, UNMOVIC retained perhaps around one third of the experienced staff from its predecessor organisation while recruiting new staff to include a broad geographic representation.

Taking into account United Nations policy, recourse to cost-free personnel was limited. UNMOVIC recruited its headquarters staff on fixed–term contracts. Only a very few selected specialists whose services were made available by Member States were engaged by UNMOVIC for its verification activities in Iraq, such as medical and communications personnel.

Both the UNSCOM and UNMOVIC staffing policies had strengths and weaknesses. The benefits (besides the gratis costs) of the UNSCOM recruitment was in the fact that many countries offered up their very best experts to be involved in the UN inspection system especially so in the early years. As time progressed, countries were more inclined to offer less experienced personnel. However a small core of UNSCOM experts with continuity was maintained and those who proved themselves exceptional inspectors were involved continually in inspections.

Continuity, flexibility, and diversity

A lesson learned from UNSCOM was perhaps the need for corporate knowledge, especially in the inspection processes and the history of the proscribed programmes. Because of staff availability, it was not always possible to get the same inspectors to do follow-up inspections under the UNSCOM employment arrangements and new inspectors spent much of their time updating their knowledge of particular facilities, issues or personnel.

UNMOVIC was able to have flexibility and diversity within the inspection teams and within its staff in New York by having a few headquarters staff, who maintained the institutional memory, and complementing these with temporary staff selected from a roster of specialists. Besides the need for expert inspectors in the field, there was also a need for experts in the headquarters who could, using the field data, make overall assessments and write reports suitable for the Security Council.

Lesson

A valuable lesson for UNSCOM, and also UNMOVIC, was the need for an optimum mix of qualifications, backgrounds, and of fixed-term and short-term staff. Both UN inspection organizations were able to incorporate broad national representation to the maximum extent possible, and using this selection as a strength rather than a limitation. While it was essential to have staff with operational expertise and familiarity with CBW systems and this was restricted to a few countries, representatives from other countries added other skills and a diversity of viewpoint which could temper or alter judgments. Thus, a core of technically competent, committed, impartial, and experienced inspectors was assembled, essential to maintain competence at the wide variety of sites and facilities that were visited as well as to successfully accomplish a wide range of tasks.

A lesson learned from UNSCOM was perhaps the need for a larger core of staff which could develop corporate knowledge in the inspection processes and the history of the proscribed programmes. Because of staff availability under the UNSCOM system, it was not always possible to get the same inspectors to do follow-up inspections and new inspectors spent much of their time learning about particular facilities, issues or Iraqi personnel.

A core of technically competent, committed, impartial, and experienced inspectors is essential for the success of an inspection regime. Institutional knowledge takes time to build and the value of such knowledge should never be under estimated.

Roster and training programme

UNSCOM inspectors were mainly trained on-the-job, and a valuable lesson learned from years of inspection activity was the need for specific training of all personnel. There are few organizations that specialize in training weapons inspectors and establishing a core of such staff was a principal goal of UNMOVIC.

With UNMOVIC, all those selected for employment at the headquarters or to be included on the roster were required to go through a developed UNMOVIC training programme. The training ensured that the inspectors, coming from a wide variety of backgrounds with diversified academic qualifications and experience, had at least a common level of understanding and technical knowledge.

To supplement permanent staff (with fixed-term contracts) on inspection teams, a roster of qualified and trained inspectors from more that 50 countries was established by UNMOVIC. The roster personnel were available at short notice, and when called upon to serve as inspectors in Iraq they were recruited as UN staff members with short-term

contracts. The personnel were experts with special skills and expertise, not only of WMD but also to specific fields of technology relevant to Iraq's declarations.

UNMOVIC devoted considerable time and resources to establish its training programme, which included developing and reinforcing core inspection skills and competences of inspectors aimed at meeting the needs of both the disarmament task and the monitoring duties. The training programme covered topics such as technologies of proscribed weapons systems, monitoring and verification methods and procedures, dual-use technology, and sampling and analysis. Training programmes also encompassed both technical and relevant safety procedures as well as cultural issues such as the importance of understanding national sensitivities. An additional benefit of the roster and training programmes was that derived from potential inspectors working together in a team before entering Iraq.

The key to the success of any inspection organisation lies in the quality (knowledge, experience, and work ethic) and background of its staff. The recruitment process of that staff must also reflect the UN norms and values in assembling a team that is not only of the highest professional calibre but also unbiased and totally independent. Using staff supplied from national governments, while even if the best qualified, carries with it the perception of national influences.

Having staff from a broad geographic distribution proved beneficial in dealing with Iraq during inspections. This broad representation seemed to reinforce the solidarity of commitment by the UN for the inspection process and it was not possible for Iraq to accuse all inspection teams of pursuing hidden agendas. Having an appropriate gender balance was also important during inspections, especially when it came to inspecting areas allocated at facilities to women or when inspecting private homes.

While it was possible to recruit personnel with a range of expertise, not all necessary expertise was readily available. The roster system developed by UNMOVIC went some way to overcome these problems but bearing in mind the extremely wide range of knowledge and skills necessary, this is not easily achievable. Having an appropriate number of linguists, interpreters and translators who were technically competent and familiar with local Iraqi jargon was a continuing problem.

Having sufficient qualified people in itself was not enough, the people recruited had to be able to work as part of a team under harsh conditions in a hostile environment.

Lesson

The recruitment process is vital to a successful organisation. While accepting staff provided by national governments can be an attractive and low cost option, the down side is the repercussions this has on the perception that such staff's first loyalties are to their own respective national governments. The lesson learned from the UN Special Commission experience is that it is a better option for the organisation to recruit on fixed term contracts, an appropriate balance of qualified experts that represent a wide geographic distribution and with an appropriate gender balance. The Executive Chairman always has the option not to renew contracts of employees if they fail to meet suitable standards.

It proved difficult for both UNSCOM and UNMOVIC to recruit personnel to cover all of the various types of expertise required. For example, chemical process engineers, fermenter experts, munitions specialists and missile engineers with the appropriate backgrounds, qualification and experience are not in abundant supply. Those who have had hands-on experience in the bulk production and weaponisation of chemical and biological agents are few in number and restricted to very few states. The roster system developed by UNMOVIC allowed it to target personnel with particular expertise and so reduce the short comings of potential gaps in expertise. The roster system proved a real asset to UNMOVIC's inspections.

8. Cooperation and coordination with other international organizations

There are many international bodies that deal with information relating either directly or indirectly to non-proliferation and WMD issues. These bodies include other UN-bodies such as IAEA, WHO, OIE, FAO and non-UN bodies like OPCW and Interpol. In the past these organizations have worked with a high degree of independence within their own specific mandate. However, it seems likely that a closer cooperation among these several organizations would lead to more effective inspections particularly as the expertise required in many areas is the same and the same issues are dealt with from different angles. Co-operation can come without the compromising of sensitive or disclosing propriety information.

Lesson

UNSCOM and UNMOVIC did benefit from working closely with the IAEA during its inspections in Iraq. Perhaps it would have proved even more useful to establish closer relationships with other international organizations, particularly in the biological area with for example, WHO, FAO and OIE.

9. Time, and general plan for achieving the goals

Time is an important constraint underlying the existence and activities of most inspection agencies and the UN commissions are no exception. The time constraint places the inspection organization under pressure – to organise itself appropriately for inspections,

to meet certain deadlines either self imposed, imposed externally or to satisfy expectations of those funding or supporting the organisation.

Along with the time constraints, both UN inspection bodies had to act in situations of high political interest. The "h*ot, bubbling pot of the political world with its mixture of emotional appeals, polemics, personal ambitions, media management, and spin"* (citation from Hans Blix) can present a challenging environment for manoeuvring and carrying out disarmament and monitoring operations. The inspection body has to be able to handle inappropriate influence or pressure, and leakage to media by member states. It is a necessity to "*listen to advice, but ignore pressure*".

Very few inspection organisations will have an open-ended time frame in which to achieve results. For UNSCOM, following the Gulf War in 1991, the main focus was on disarmament and in particular, destroying, removing or rendering harmless the prohibited missiles and chemical weapons and bulk agent as declared by Iraq. The destruction and neutralisation of chemical agent and weapons took a dedicated team around three years to complete. There was no biological warfare programme declared although UN inspectors did remove bacterial isolates presented by Iraq.

In the early inspection years, the Special Commission gave priority to disarmament actions. The resources were focussed on chemical and missile disarmament where concrete results could be achieved within a specific time frame. Fewer resources were allocated to the biological area, where only concerns of a BW programme existed.

Over the course of the existence of the Special Commission, the time constraint itself became less of a factor but the longer the process of inspections, the greater the chance of issues arising to fracture opinion both within and outside the Security Council.

In late 2002, when UNMOVIC was about to commence inspections in Iraq, it was clear that time would be a limiting factor. Already rumours of war were rife as US and other forces were deployed in large numbers in the Gulf region. In a tense international atmosphere where war seemed inevitable, there was tremendous pressure on UNMOVIC do as many inspections as possible, to follow all leads, to conduct investigations on the basis of information from major political players, intelligence information supplied by governments (underground facilities, mobile laboratories) and information from open sources. UNMOVIC operated under an intense sense of urgency to cover all of these leads while following up when possible, on some of its unresolved disarmament issues.

From 27 November 2002 to 18 March 2003, 731 inspections (on average more than six inspections per day, 7 day week) covered 411 sites (88 of which had not been inspected before). The sites comprised declared and undeclared sites, palaces, Republican Guard facilities, military storage and repair facilities, private homes and farms, private companies, and many governmental facilities.

Lesson
Underlying the modus operandi of the UN inspection regimes was the time constraint and expectation of some members of the Security Council. When established, the conventional wisdom at the time suggested that the Special Commission would have a life of perhaps a year or less. When the extent of the disarmament and monitoring activities were realized, the UN Special Commission had to adjust to the new circumstances.

UNMOVIC inspection operations in Iraq were in a completely different environment from those of the Special Commission. Had UNMOVIC not been under such a stringent time constraint, the inspections could have been more detailed and thorough and many issues which emerged could have been pursued to a conclusion allowing greater confidence in the inspection process. Strict time constraints will limit not only what can be achieved but will also limit the confidence in the inspection results obtained.

10. Export/Import Control/Mechanism (Joint Unit)

In March 1996, Security Council resolution 1051 (1996) approved an import/export mechanism that assisted the monitoring aspect of inspections. This was the first time that such a mechanism had been introduced to an inspection process. This mechanism proved an enormous benefit to the UN Special Commission as it allowed the Commission to check effectively the end user of all new imports of dual-use equipment and material entering Iraq. The equipment checked at the point of entry or central customs depot inside Iraq and also once installed in a facility and this was verified by repeat inspections. In addition, information provided to the Special Commission by both the supplier and Iraq allowed a crosschecking of all data. This mechanism was also welcomed by Iraq. This import/export control regime allowed Iraq to import some dual-use equipment for legitimate purposes.

Lesson
For the monitoring of ongoing activities an Export/Import Monitoring Mechanism is a critical component. A declaration system for information/notification should be part of the mandate of an inspection system. The lists of dual-use equipment, to be subjected to monitoring, should be based on updated technological assessments.

11. Support for Operations

Guide-lines and formats

Underlying any inspection operation are the rules and procedures that govern the operation of the inspection regime. Sometimes these guidelines are formal and are established through agreed Standard Operating Procedures (SOPs) or sometimes more informally as by a letter of instruction or Minute.

As UNSCOM commenced inspection activity in Iraq within weeks of being established, there was little time to formally prepare instructions for the inspectors and activities were guided by the relevant Security Council resolutions. The various chief inspectors, particularly in the early years, used the established procedures with which they were

familiar for issues such as health and safety, communications security, and sampling and analysis. There were no SOPs mandated although some de facto SOPs emerged as required on an ad hoc basis. Methodologies and inspection techniques were sometimes passed on to successive inspection teams but much responsibility for the conduct of inspections lay in the hands of the chief inspector.

As UNMOVIC had a two year time lag before commencing operations in Iraq, it assembled SOPs and other guidelines aimed at providing effectiveness and uniformity in operations and reporting without neglecting issues such as security and safety. The documents assembled included detailed internal procedures and policy documents such as an administrative manual, a glossary of terms and definitions, and a handbook. The Standard Operating Procedures (SOPs) established for activities such as sampling, tagging and health and safety were regarded as living documents to be updated through experience in the field. These guidelines proved a valuable asset to the inspectors and proved a valuable lesson in what to do right.

Administrative manual

The UNMOVIC administrative manual is a compendium of administrative rules and procedures covering, inter alia, communications and records, personnel matters and management of confidentiality. As a supplementary document to United Nations established rules, the manual was intended to guide UNMOVIC personnel in the discharge of their responsibilities.

Handbook

The UNMOVIC handbook is divided into three parts. Part I covers all aspects of UNMOVIC operations and activities, inter alia, inspection and reinforced ongoing monitoring; aerial surveillance; transportation; accommodation; UNMOVIC rights and responsibilities; relations with the media; and Iraq's obligations. Part II contains discipline-specific procedures as well as policy documents on, inter alia, sampling and analysis of chemical and biological weapons agents; sampling of solid propellants and their ingredients; tagging of missiles; and disposition of prohibited items or unidentified dual-use items. Part III contains the texts of relevant governing resolutions and related legal instruments.

UNMOVIC was guided by the provisions of the handbook in its activities. The handbook was also used as a reference basis during the talks in July and September/October 2002 held between UNMOVIC, IAEA and the Government of Iraq on the practical arrangements related to the resumptions of inspections in Iraq.

Health and safety, and environmental issues

Health and safety issues were recognised as a crucial element in the inspection process and as such were always given top priority by both UNSCOM and UNMOVIC. Instructions were given by the Executive Chairmen never to compromise the safety of inspectors to achieve mission goals. Even though the health and safety procedures were more formally established by UNMOVIC, both systems achieved remarkable results in safety standards. Despite the extremes of environmental conditions and the arduous and

often quite dangerous tasks performed, few serious accidents occurred. UN inspectors were supported by an organic medical team that maintained a small staff in Baghdad with an appropriately stocked clinic. Medical support personnel were available to accompany inspection teams if requested. In addition, a UN chartered helicopter was maintained on stand by at Al Rasheed air base at all times for medical evacuation purposes.

Comment
Both UNSCOM and UNMOVIC had few serious casualties in the field and to some degree this was due to the instituted SOPs and work practices developed through the course of inspections. However, on occasions the safety record was due to good luck and good fortune. It is almost impossible to conceive of a large number of inspectors who vary in age, physical and mental condition and background, and perform dangerous tasks under at times brutal environmental conditions over a number of years and with little cooperation at times from the host country, not having many casualties. In the case of UNSCOM in particular where inspections occurred for several years and included a group dedicated to the destruction of chemical weapons and agents, the record is remarkable. Ironically despite the dangerous nature of many inspections, the greatest hazard to health was from vehicle accidents: other hazards were from heat stress and contaminated food and water supplies.

Infrastructure and Logistics

Getting inspectors into the field with the correct logistical support is a huge task as shown by the UN inspection experience. UNSCOM used a field office established in Bahrain as a staging point for inspections in Iraq. It was in Bahrain that inspectors assembled, were briefed into the mission and undertook limited training and preparation. For disarmament inspections, much of the final report writing took place at the hotel used by most inspectors.

UNSCOM used a chartered aircraft to ferry personnel, equipment and materials into and out of Iraq. A fleet of four wheel drive vehicles and six helicopters and crews were donated by supporting governments for use as internal transport. After a temporary location at the Palestine Hotel, UNSCOM, in 1994, established its main operating base, the Baghdad Monitoring and Verification Centre (BMVC) at the Canal Hotel, a facility later shared with some other UN agencies.

As the system of logistics established for UNSCOM worked well, UNMOVIC repeated much of the network for its inspection activities. In addition, the renamed Baghdad Ongoing Monitoring and Verification Centre (BOMVIC), was supplemented by UNMOVIC with a regional office in the northern city of Mosul. The Iraqi Government also established a regional branch of its National Monitoring Directorate in Mosul to support UNMOVIC activities.

Comment
The chartered L-100 aircraft proved extremely reliable and responsive at short notice for moving people and equipment quickly into and out of Iraq. Even when evacuations occurred as in 1998, response was immediate. The number of times that the aircraft was

unserviceable and caused inspection delays was minimal. It is difficult to conceive that such reliability and service could be repeated with such few human and aircraft assets.

Lesson
Operating a regional office provides several advantages, such as increased number and efficiency of inspections due to the relatively short travel distances. It reduced the logistical problems with remote location sites in the north. Successfully operating a regional office depends heavily on available staff and support and an effective communications system with the main operations centre

Overhead Imagery and Aerial Surveillance

Both UN inspection agencies recognised early the potential benefits of overhead imagery for the planning and conduct of inspections as well as for analysis of site capabilities by enabling the determination of the status of a site (activity), its layout and dimensions, and possible functions of particular structures. Overhead imagery was obtained from satellites, high and medium altitude surveillance aircraft and from helicopters. Imagery from these sources complemented each other and was supplemented by ground-based photography.

During UNSCOM's inspection activity, satellite imagery and its interpretation were provided by governments as was a U-2 surveillance aircraft that was provided free of charge by the US and painted in UN colours (Figure VIII.I).

Figure VIII.I U-2 Aircraft used for UN Missions

Imagery from helicopters was also used extensively by both inspection agencies and much of the most detailed site imagery comes from this source.

During the transition of UN inspection agencies from UNSCOM to UNMOVIC much of the imagery-related technology had changed particularly that related to resolution and image quality. With regard to satellite imagery, UNSCOM relied almost exclusively on imagery provided by Member States and this had important advantages in that it was

cost-free and good quality imagery was made available with interpretation. UNSCOM did operate a film processing unit for some imagery but much was also processed commercially in Bahrain. These advantages were also perceived as disadvantages as they helped to cast doubt on the information provided and UNSCOM's dependence on it.

By the time of UNMOVIC's establishment, the resolution, quality and timeliness of commercial satellite imagery had increased enormously from almost a decade earlier. Rather than depend on imagery supplied from member states, UNMOVIC opted to purchase commercial satellite imagery. The use of commercial satellite imagery had the advantages of self-reliance and flexibility in the acquisition of information particularly since commercially available imagery in 2003 had a resolution of 0.60 metres.

UNMOVIC established an imagery evaluation unit, like UNSCOM, that not only processed the specialized non-commercial imagery provided by governments, but also acquired and processed commercial overhead imagery. In addition, UNMOVIC used high-altitude (U-2) and medium altitude aircraft (Mirage) at no cost to the UN and was experimenting with (German) UAV platforms for the supply of real time imagery. Although there was still an element of support from member states this imagery support was balanced with what UNMOVIC could procure from its own sources. In addition, one of the helicopters contracted by UNMOVIC was equipped for the acquisition of aerial imagery during day and night and was used for surveillance.

Lesson
Imagery is an important source of data for site analysis and planning and conducting inspections and both UN inspection agencies benefited enormously from imagery supplied from a range of platforms. Without such data, planning inspections would have been much more difficult and site analysis incomplete. Having, and being seen to be having some UN procured data sources, lends credence to the independence of the inspection agency and its operations. The increased commercially available high resolution satellite imagery allowed UNMOVIC to build up an independent information-gathering, search and analytical capability which complemented imagery supplied by platforms supplied by member States. This assisted the UN body in prioritizing its inspection sites. Satellite imagery has also been useful for monitoring site activity since the inspectors were withdrawn from Iraq

Communications

A communications centre was established for field operations by UNSCOM and from 1994 it was located in the Canal Hotel and was staffed by experienced communications personnel supplied by New Zealand. The building was especially wired to UNSCOM specifications and redundancy was established. These arrangements were continued by UNMOVIC.

UNSCOM and UNMOVIC used satellite radio (IMARSAT), telephone and fax system and hand held radio systems for communications either between field staff and New York or within the area of operations itself. Some communications systems between New York

and the Canal Hotel were encrypted for more secure transmissions although any material that was regarded as extremely sensitive was sent by messenger. All UN inspection staff in Iraq was supplied with hand-held radios (with spare batteries and chargers) for normal as well as emergency communications. In addition a separate landline system was provided in isolation from other communications systems and was used to contact local Iraqi officials.

Comment
The separate and redundant systems as well as the encryption provided some although by no means total security for voice, data and fax transmission. The encryption was provided with cooperation from a member state and was more advanced than most commercially available at the time. It was recognised that although it would have been possible for some countries to decrypt the messages, this would have come at considerable cost and required a significant level of sigint expertise. For the UN to contract out its own encryption system would also have come at considerable cost and taken time to develop with few guarantees that it would have been any more secure than the one chosen.

The wiring in the Canal Hotel was installed in such a way as to minimise the possibility of compromising the communications systems.

Lesson
The daily communications systems which linked inspectors in the field with the canal Hotel, worked well and this was due in no small part to the thought and skill of those who installed and operated the system. So for the inspection regimes this was something done right. The Canal Hotel communications centre was staffed 24/7 with experienced operators. The system was not unduly affected by the extreme heat or other environmental factors. Having a reliable communications system was vital especially when inspectors are involved in dangerous duties at remote locations. For example, in December 1998 when UN inspectors were withdrawn from Iraq, one group of inspectors were camped out at a remote desert location observing a missile test. These inspectors had to be contacted and at short notice to immediately withdraw from the country by a specified route: a reliable and adequate communications system was essential. Redundancy is also a "must have" requirement.

As far as the encryption systems were concerned, although one developed specifically for the UN inspectors may seem ideal it becomes a matter of cost and priority as to the system chosen. For UN inspectors it was a priority to protect transmissions against interception by Iraq so that mission data would not be compromised: it was not so essential to protect transmissions against countries with the most sophisticated decoding systems.

Information systems
Information is an essential component of a monitoring and verification regime, whether the information is provided by Iraq (in the form of declarations or letters), through

interviews, generated by inspections, or from any other source including data supplied by other countries. A number of problems surfaced with regard to the information receipt, storage, handling and retrieval system both within the UNSCOM and UNMOVIC system.

When UNSCOM was established, the popular belief was that it would exist for a short period of time, perhaps a year or so at the most. With this assumption in mind, there was probably little thought of establishing long term structures to support the many additional demands placed on the information system. The main focus of UNSCOM was to destroy, remove or render harmless Iraq's WMD programmes; there was no anticipation of receiving the huge volume of material that accumulated in the Special Commission over the years, such as the Haidar Farm documents.

Thus, one problem and a major lesson learnt related to keeping tabs on the sheer volume of material in very many different formats such as paper, photographs, maps, diagrams, computer files and other electronic formats as well as physical items and samples. The need to establish and maintain a separate registry system, which is able to catalogue, classify, store retrieve and archive such data while keeping it protected and within a chain of custody is an enormous challenge. The alternative to this is to have reports, photographs, original documents and other material either misplaced, lost or stolen. Creating a central registry to register and maintain original copies would seem an ideal solution. However constraints of staffing and space often mean that compromises occur.

Although both UNMOVIC and UNSCOM tried to maintain such a register, either through individual disciplines or through a centralized system, both had shortcomings.

Lesson
A principle lesson learned from the UN experience is that much more effort is needed in the planning stages to set up and operate a registry system for all incoming and outgoing material than was afforded. The system of receiving and registering data of all types and all formats evolved along with the inspection process. Having a system of storing, sorting, and retrieving material either physically or electronically, did not work well and as a result, some documents were lost, misplaced or stolen. Along with the sheer volume of information received and reports generated, a further lesson learned was the need to classify all material for future archiving purposes. This was not done completely by either UNSCOM or UNMOVIC and had to be addressed after the fact making the whole process more time consuming and difficult. Although some of the shortcomings above reflect both staffing and other constraints, a valuable lesson for future inspection regimes is to prioritize the way in which data (and physical items such as samples, electronic components or Scud engines) will be received, handled, stored, retrieved and archived.

On another scale, the establishment of a central computer system at the Canal Hotel, providing consistent and compatible software for each inspector and having sufficient numbers of laptops was not always done by either UNSCOM or UNMOVIC. Problems also existed with data transmission between the field office in Baghdad and the New York Headquarters. These difficulties proved not only annoying and irksome to those in

the field but also reduced the efficiency of preparing and transmitting reports. It was not possible for inspectors to access the necessary data at times to prepare adequately for inspections.

When, on orders from the Executive Chairman, UNSCOM was evacuated from Baghdad in October 1998, since many computers hard drives were not removable, these hard drives were destroyed. When UNSCOM inspectors returned to the field a short time later, the computers had to be either replaced or repaired. With the smaller, lighter and much more capable laptops which exist in 2007, this problem of removing sensitive data at short notice would seem to be one of the past and not one of the future.

Lesson
Experience suggests that there will rarely be enough computers and associated devices to satisfy the needs of an inspection body and this is probably not unique to the UN inspectors. However having sufficient laptops and backups, the necessary supplementary equipment, the right physical connections to the local power supply and most importantly the necessary personnel to maintain this equipment is essential to the success of an inspection agency. The ability to store enormous quantities of data is not a challenge with modern hardware and backing up data on a frequent and regular basis in the field is essential especially in a country like Iraq, where power failures and blackouts were frequent. Much data could and was either corrupted or lost through insufficient storage or lack of necessary equipment. The same principles apply of course to data held in the New York Headquarters however these problems were not so pronounced.

Security

In line with many UN operations, the UN inspection agencies relied on UN security guards for perimeter and building security and on the host government to provide the necessary internal security arrangements. The Canal Compound was compartmented and a guard policed access to the restricted areas operated by UNSCOM and UNMOVIC. Access was available only to UN inspector personnel and appropriate maintenance and cleaning staff under supervision. Individual offices had coded access locks and laboratories had dual-doors with locks and restricted access. The offices were electronically swept from time to time to reduce the likelihood of eavesdropping devices being planted by Iraq.

Special arrangements were made when inspection teams had to operate in non-government controlled areas of Iraq such as in the Kurdish areas. Again coordination was through the local UN security body in that area.

The evacuations that occurred with UN inspectors did so smoothly and without incident because of the effective contingency plans and arrangements in place and in no small part because of the cooperation and assistance of the Iraqi security personnel. Fears and concerns of hostage taking never materialised and quite the opposite, not only was there no obstruction from Iraq but Iraqi personnel offered welcomed assistance.

Lesson
Security of all of the deployed staff is obviously a primary concern of any inspection regime. The security arrangements employed by UNSCOM and UNMOVIC generally worked well: it was a case of leaving the security arrangements up to the security experts and abiding by the guidance that was in place.

The Security arrangements operated well even in the cases of very short-notice evacuations.

Contingency plans are a must. At any one time with inspectors scattered over different areas of the Iraq and far from Baghdad, it is vital that each chief inspector knows what to do in case of an emergency.

Protection of received information

The UN inspection agencies realized early that even a cooperating country is understandably reluctant to share sensitive or confidential information with an international organisation unless it is convinced that appropriate protection arrangements exist for the information provided. Such arrangements have to be in place and demonstrated to be sufficient before trust and confidence can be established. Conceptually at least, despite the physical and other arrangements that may have been established, it was more difficult for UNSCOM than UNMOVC to prove these credentials as many UNSCOM staff were provided by member states.

Private companies and individuals also supplied much information. UNSCOM received a great deal of very helpful and valuable supplier information related to material and equipment sent to Iraq. This information was crucial in helping to evaluate the declarations made by Iraq for its individual WMD programmes.

UNMOVIC from the beginning established an office for outside information sources that, apart from the Executive Chairman, was the sole entrance point for intelligence information provided by governments. Although recognizing that a dialogue with providers was necessary in order to seek clarification and to indicate what may be of particular interest to the organization in discharging its tasks, UNMOVIC established that the flow of intelligence must be one-way only to UNMOVIC and have regard only to matters relevant to the mandate of UNMOVIC. Having a one way flow of information goes against the natural premise of “if you don’t give, you wont get”. Understandably any organisation would want to know whether the information they provided was good, bad or indifferent and would expect some feedback accordingly. While the one way flow policy may have discouraged some information being sent to UNMOVIC, it did reinforce the *modus operandi* of the organisation and its independence.

Process for evaluation of received information

Once received, information has to be assessed an evaluated before it can be used either in the field or for reporting. The UN inspection agencies always tried, as far as possible, to have the information corroborated by other independent sources. In most organisations

there can be many interpretations placed on data supplied, its reliability and accuracy and on the source, and the UN organisations were no different in this respect.

It remains a matter of judgement as to how much information was or was not withheld from the UN inspection bodies because of a fear of that information being compromised or from the one-way flow policy introduced later. Not only was it government information that was withheld, often private companies withheld much information that may have proved valuable.

Lesson
The need to demonstrate appropriate security of information provided by outside bodies is essential before any information sharing of substance can be expected. Trust and confidence can only be built up over time but without the physical protection and the "need to know" principle in place along with a restricted access and distribution system, countries will be reluctant to cooperate on this issue. At best cooperation with member states will be uneven and expecting total cooperation from the private sector is naïve.

Public and Media Relations

At times during its inspection activities, both UNSCOM and UNMOVIC were subjected to intense media and public interest. While the Executive Chairman remained the spokesperson for the organisation, an official point of contact was established to deal with enquiries by the media and general public. It was essential for both organisations that an experienced person (both in New York and Baghdad) was made point of contact particularly during the politically charged and sometimes tense atmosphere that existed at times.

With regard to information sharing with the public, both UNSCOM and UNMOVIC realized the demands that would be placed on the organizations and wisely limited the authorized points of contact with the media. This policy worked well for the UN inspection bodies. Public comment by inspectors was then easily limited to the scientific, technical and factual issues surrounding the inspection process while political evaluations or comments were left to the Executive Chairman and the Security Council.

Lesson
It was a wise move for the UN inspection organisations to identify early the need to have an experienced public relations officer as the point of enquiry. This meant that consistent information could be given with minimum risk of compromising sensitive data. In addition, the media had a point of contact besides the Executive Chairman.

Although chief inspectors were often asked to comment on the results of particular inspections, their comments were limited to technical and specific issues. It would have been easy for individual inspectors to give misleading or wrong information on issues outside their immediate area of expertise and such views or statements could easily have been distorted or used to create unnecessary concern.

It was essential for a public relations officer, who was aware of a broad range of issues

and policies to be part of the inspection process.

12. Inspection activities

As mentioned in earlier parts of the compendium (Chapters I and II) the inspection methodologies and activities evolved over time and according to circumstances. With respect to specific verification methods and procedures, UNSCOM developed its own including developing techniques for on-site no-notice inspections, document exploitation and interviews. As UNSCOM's successor, UNMOVIC further developed these techniques based on the experience it inherited from UNSCOM and, in some areas it acquired more resources and advanced specialized tools. New inspection technologies were tried for the first time by both inspection agencies.

More than a dozen years of inspection and verification experience in Iraq by the UN inspectors have resulted in some important lessons learned and have also highlighted some dilemmas for an inspection regime. Some lessons with regard to inspection activities were common to all disciplines and these will be discussed first before exploring the lessons for discipline specific activities.

The inspection experience gained by UNSCOM and UNMOVIC demonstrate that an effective and comprehensive verification system is based on two major elements: (a) institutional knowledge encompassing a detailed experience and expertise gained from inspections and (b) technical capabilities comprising verification technology and other necessary specialized assets.

Lesson
Institutional knowledge and a wide variety of technical capabilities are rarely available instantly. Even with the best experts available, UNSCOM demonstrated that it takes some time, effort and resources to accumulate a credible capability and to either introduce or fine-tune the necessary inspection process. Learning from UNSCOM, UNMOVIC realized that in order to have a well-trained cadre of inspectors available at any time, again this is not costless and without considerable effort but that the benefits proved well worth it.

Multidisciplinary approach

In 1991, when the inspectors began the verification of Iraq's declarations of its proscribed weapons programmes, they did not know how deeply these programmes had been integrated in Iraq's military industrial infrastructure. As was revealed during the course of verification and monitoring there were manifold facilities involved in proscribed programmes, and they had multiple links to other military industrial facilities and benefited from their support. Thus, it was necessary for a successful result of UN activities to apply a multidisciplinary approach. The multidisciplinary approach went far beyond the concept of just having inspectors from other weapons disciplines mixed in a team in case something not recognizable in one discipline was of interest to another.

As a result of the multidisciplinary approach, a more complete understanding of the sites was developed. It was possible to obtain, in addition to information ascertained under a specific discipline, complementary information about procurement, contracts and relationships with other companies and national and foreign suppliers.

The need for a multidisciplinary approach is as an example demonstrated by the build-up of the Iraqi BW programme. About 30 different facilities, both civilian and military and with different kinds of expertise and activities, were involved in this programme. Several of these facilities were also involved in the missile and CW programmes. Their contribution comprised the supply of educated personnel, design and construction of BW facilities, procurement (of isolates, equipment and materials), manufacturing of equipment and weapons, research and development, and production of agents.

As another example, the production of Iraq's CW munitions was directly linked to the design and production of its conventional munitions. A detailed understanding of the original conventional munitions materials, design and manufacturing process was needed before Iraq could make the subtle modifications necessary to convert these conventional munitions into chemical munitions. International inspectors also require such an understanding. This implies that international inspectors require access to all military establishments involved in the production of arms and their components to ensure that all aspects of weaponization are identified and understood. However by doing so, the inspection regime runs the risk of being accused of over stepping its mandate. Again a lesson learned was the need to establish boundaries to avoid the frequent disputes that occurred between the inspectors and Iraqi authorities.

The dilemma for the inspectors with this approach however was the degree to which investigations could go for industries and facilities not directly (perhaps quite indirectly) associated with the WMD programme. There was at times some confusion as to whether the tasks were restricted only to WMD or whether the tasks were to assess WMD capabilities or even WMD potential. As industries are often linked widely with others industries, drawing an appropriate delineation was usually a matter of judgment and not always easy. Some more specific examples especially with munitions are mentioned in detail later however what was or was not relevant to the inspection process was not always consistent either within disciplines or between disciplines.

Lesson

The multidisciplinary approach that operated in a de facto manner in UNSCOM and was more formalized during UNMOVIC proved a more robust approach than relying solely on specific discipline based inspections.

It is not always possible to capture the breadth of inspections necessary before the inspection process begins. Goal posts and objectives will change as knowledge and experience are gained. However given these circumstances, it is incumbent on the headquarters to define the boundaries of all inspections so that they are carried out in a consistent manner rather than leave it up to the judgments of individual chief inspectors. This will reduce both the confusion within the inspecting staff and for counterparts in the host country.

It would not have been possible to establish multiple links between different proscribed weapons programmes and support to these programmes provided by other establishments if the verification process had been limited to the boundaries of an individual programme.

A monitoring and verification system should make maximum use of synergies, cross checks and cross fertilizations between the activities of the four disciplines (nuclear, biological, chemical, and missile) and the Export/import Monitoring Mechanism in order to ensure confidence in the continuing absence of proscribed activities as well as clarification and progressive resolution of disarmament issues. The benefit of the integrated approach would be that all information gathered from these concurrent activities would be analyzed systematically, considered against other data and examined in a multidisciplinary context.

The Role of the Chief Inspector

The UNSCOM chief inspector, whether for disarmament focused teams or resident monitoring teams based in Baghdad, had total responsibility for the entire team, including their health, safety and welfare, every minute that team was in Iraq. In addition the chief inspector reported to the Executive Chairman either directly as was the case with UNSCOM or through the Director of Planning and Operations as was the case with UNMOVIC, on the conduct of the inspections and on the interaction with Iraq's National Monitoring Directorate counterparts. Then role of the chief inspector was much more than providing technical advice or coordinating reports for New York.

As such the quality of the chief inspector often was an important factor in determining the success of an inspection or a monitoring period. Given the very diverse range of backgrounds, ranks, seniorities and experience of individual team members, maintaining team cohesion, focus and discipline was far from an easy task let alone making sure that each inspection was thorough and complete, the inspection report was concise and well written and salient points were transmitted back to New York daily. For many team members the working environment and relations with Iraqi counterparts and site officials together with the harsh climate especially in summer and unfamiliar food, at times poor sanitary conditions and basic accommodation, proved especially stressful and the chief inspector had to be aware of, and address any such stresses within the team.

Lesson
The selection of a chief inspector will in a large part determine the success or otherwise of the mission and this was especially important with regard to monitoring teams who spent on average 90 to 100 days continually in country. In selecting a chief inspector, academic or technical experience should not be the only factor and in fact should be a secondary factor to the many qualities involved in managing a team and producing results.

The Problem of Coordination between Inspection Teams

One problem encountered by UNSCOM teams was the difficulty of maintaining information security especially in relations to sites to be inspected and coordination of

inspections with the many other visiting and resident teams in Baghdad. Some coordination had to occur to manage the limited number of vehicles, medics, translators and perhaps helicopters available and this was usually done through weekly meetings with the head of BOMVIC. However difficulties and embarrassments developed when teams of different disciplines arrived simultaneously at the same site or when a team thought that they were going to a new site for the first time only to discover that it was regularly inspected by another discipline.

To some degree these difficulties were recognised by UNMOVIC that had Planning as part of the Division of Planning and Operations but UNMOVIC's field experience was not long enough to gauge the success of such a strategy. It would appear however that having all field operations centred through one Division rather than by discipline would minimise the risks of overlapping or competing inspections.

Lesson
Having a Division of Planning and Operations is a far more attractive alternative than having individual disciplines prepare their own inspections. Much coordination can be achieved and without compromising the sensitive information. A lack of coordination and sense of purpose gives the appearance of a lack of professionalism.

Translators/Interpreters
As a general rule of thumb, there are never enough translators or interpreters. Many interpreters involved with the UN inspection regimes, had their origins in countries in the Middle East in countries other than Iraq. Arabic, like English, is not a standardised language through out the Middle East and words, expressions and nuances can vary widely within one country let alone between countries. So being an interpreter or translator required skills other than just being familiar with the written or spoken word. It required someone preferably with a technical background and well versed in the local country nuances for without this knowledge, it was easy to misinterpret words and meanings and or skew completely something that was said or written. In addition, some languages do not lend themselves to precise interpretation, as no exact words exist for a particular meaning.

Both UN inspection agencies relied heavily on interview testimony and documentation as a source of knowledge for the past WMD programmes. Therefore any mistranslation or misinterpretation could have tremendous consequences on understanding what was being said and UN inspectors could easily perpetuate this misinterpretation as a truism. There was a tendency for UN inspectors to think that interview testimony was evidence similar to that in a court of law and that what was said, no matter how poorly or imprecisely, could be scrutinised and dissected and be used against the interviewee or colleagues at some time in the future. As UN inspectors found, this mentality can be hazardous. All too frequently, documents examined by a second translator, had a different interpretation or differed sometimes slightly sometimes markedly from the first.

Lesson
There are no easy answers to having a sufficient supply of technically and culturally

trained translators and interpreters. The reality of life is that the UN inspection agencies had to make do with the numbers of people with appropriate language skills available and in most cases these people did a very good job. It is unreasonable, however, to expect that the technical skills of interpreters will range from missile guidance and control technology to complicated analytical chemistry to microbiology. Double or crosschecking translation of documents can be one way of minimising errors although it doubles the effort. With thousands of pages of documents as occurred with the Haidar Farm cache, such careful and cross checking of translation would require enormous time and effort to complete.

In the case of Iraqi scientists, many of them spoke English (sometimes French, Russian or other languages) fluently and therefore inspectors could conduct interviews and discussions using the language skills of the Iraqis. However, it should always be assumed that those being interviewed have the right to use their own native language to minimise their chances of inadvertently saying something wrong. It is therefore incumbent on the UN to make sure that the numbers of interpreters are sufficient for the task in hand. Due caution is required in taking exact word for word translations; such an approach can prove misleading and distort what is being said.

Photography

Hand-held photographic evidence was one of the most important sources of evidence procured by the UN inspection agencies. In the case of photography, this is one of the rare instances where the UN started off well and became worse but a very valuable lesson was learned from this. Early on in the inspection process, UNSCOM included a professional photographer as part of the inspection team. This proved a winning move as the quality of film-based, digital and video imagery was of the highest quality, imagery was annotated appropriately and records duly kept.

In later inspections by UNSCOM and UNMOVIC perhaps it was assumed that with the progress in camera and particularly digital technology, that the inspectors with minimal training could take good or at least acceptable quality imagery. The reality was that the imagery taken essentially by amateurs was very uneven and disparate and varied from acceptable to woeful. Such imagery included that which was either unfocused or non-annotated and where at times it was not at all clear even what the subject matter was. In addition some of the video was almost “unwatchable”.

Rather than being an asset and a record of an inspection that can be viewed and analysed later, some of the imagery was either of such poor quality or not labelled sufficiently that it was almost impossible to use in the reporting process. The imagery data sheets that were meant to accompany the imagery themselves were either poorly completed at times or left blank. Much depended on the chief inspector and although the volume of hand held imagery increased over time the quality was sometimes sorely lacking.

Lesson

Sometimes the simplest lessons are the most productive and on reflection of the UN inspection effort in Iraq, having a professional photographer during the most important

missions is an essential. Photographic data can be extremely valuable particularly when evidence is being collected and later reviewed. Having good quality imagery that can be exploited and used in conjunction with other material such as interview testimony or documentation can be invaluable. Over time, with personnel changes and fading memories, imagery that is not documented well becomes of little value.

Documents

Documents are a very valuable source of both data and evidence. In any proscribed programme much is documented and this includes details relating to personnel involved, facilities, research and production results, and weaponisation and financial and equipment transfers. However, before being accepted as valid evidence, documents have to be authenticated, translated and analysed. As UN inspectors learned, documents are easy to destroy, hide, withhold, and forge.

Although a valuable source of evidence, UN inspectors learnt that it was unlikely to uncover a concealed programme through documentation alone. It remains doubtful that inspections alone, no matter how fast and targeted they may be, will be able to prevent the concealment or destruction of relevant paperwork. Only documents held outside the country – for example in supplier countries and at foreign banks – may be accessible to the inspectors and that is not always guaranteed.

Lesson
Documentary evidence although important must be authenticated and matched with other evidence. UN inspectors were passed forged and misleading documents as well as documents that were either draft versions or just notes or diary entries made by individuals and these had to be assessed and judged accordingly

Interviews

On many occasions, interviews were conducted with Iraqi personnel associated with the WMD programmes. Interview missions were notified in advance at times to ensure that appropriate people would be made available. These interviews were different from the discussions at the site or facility with managers and heads of departments.

In order to extract the maximum value from an interview, the interviewers must have a thorough knowledge of the topic and must know exactly what the line of questioning should be. In many cases UN inspectors asked vague questions hoping that somehow a revealing response would produce a lead and allow for follow up questioning. This did not prove productive. Techniques for interviewing were not well known and varied according to the individual inspector's personality and knowledge. Interviews were made more difficult at times by the need for interpreters and it was not always possible to ensure an exact translation, either in word or in nuance, was conveyed to the interviewer.

In addition, Iraq did not always cooperate and provide the people requested by UN inspectors and this proved more than an irritant to UN inspectors at times. Also given the regime in Iraq care had to be taken at the way questions were phrased. It was a delicate balance to try and extract the required information out of the interviewee without placing

them at undue risk should he/she either makes a mistake or inadvertently said something that embarrassed the regime.

Recordings of interviews likewise varied enormously in quantity and quality. Audio recordings at times were not understandable when reviewed and video recordings varied from fair to almost useless reflecting the absence of a professional in operating the equipment. Similarly, when notes were compared after the interviews, it became clear that those doing the interviews interpreted very differently what was being said.

Lesson
Interviews are special types of inspections for which the team which must be well prepared. This requires detailed subject knowledge by the interviewers and a carefully prepared plan detailing which questions will be asked by whom and when. Appropriate interpreter, audio and video recording resources should also be available and the mechanical devices should be tested immediately prior to the interview session commencing.

Sampling and Analysis

UN inspectors took and analyzed samples to verify Iraq's declarations, but also to check that inspection activities were conducted in a safe environment. In most cases, samples were taken by either a designated sampling team or by selected team members who had the requisite specific qualifications and skills. The regime developed by UN inspectors for sample analysis and verification followed a three-tiered approach; on-site screening, screening at a field laboratory set-up in Baghdad, and confirmation of results by certified, contracted independent outside laboratories. Because the results of sampling and analysis will always carry the notion of 'scientific' evidence and thus have a strong influence on decision-making, it was imperative that sampling was performed with reliable, accurate, specific, and sensitive methods. The results of sampling and analysis always required careful assessment as both false positive and false negative results can occur.

Based on earlier experience from inspections and investigations in Iraq, the following guidelines for sampling and analysis were developed by UNMOVIC:

- Where possible, samples were split (perhaps in four) with two available for outside laboratory analysis, one portion of each sample given to Iraq and another retained by the inspection body (UNMOVIC) as a reference,
- Samples were independently analyzed by at least two certified laboratories following strict chain-of-custody procedures. This allowed for greater confidence and objectivity in the results, with less chance of procedures or results being questioned.
- All samples, as well as raw data and analytical results generated in the course of analyses by the outside laboratories, remained the property of the inspection body (UNMOVIC), and
- All conclusions and assessments of analytical results were the responsibility of the inspection body (UNMOVIC).

Through sampling and analysis in the CBW area, additional issues of importance were identified:

- Thorough and multiple sampling should be performed including all items and relevant utilities on site, preferably based on information for optimum sampling points from the manufacturer. A limited sampling strategy risks missing relevant information and may even be counterproductive. It is possible that an adequate sampling policy comprising environmental, background and investigation-related points at facilities used by Iraq for its biological weapons programme could have enhanced the chances of detecting proscribed materials at an earlier stage.
- Samples should be kept for a sufficient period of time to, in view of the rapid developments in biotechnology and in particular the associated diagnostic and analytical techniques, enable analysis with improved and more sensitive methods. At the time of the start of inspections in Iraq in 1991, the technology to analyze biological samples contaminated with a mix of disinfectants was not well developed. Subsequently, with the improvements in scientific diagnostic techniques, those same samples have tested positive to the anthrax strain used by Iraq in its BW programme.
- Sampling and analysis should be performed at the earliest stages of verification and be considered as a routine procedure to collect more verification data rather than an extraordinary measure to verify specific concerns. Traces of VX degradation products on chemical process equipment were found only in 1997, after VX production had been established and the specific production plant used by Iraq for that purpose had been identified. Special missile warhead fragments that had initially been verified in 1992 were finally subject to thorough sampling and analysis only in 1998.

To be effective, sampling and analysis required sufficient preparation, trained inspectors and the constant updating of analytical procedures. Even the results of extensive sampling and analysis may be limited, owing to the technical limitations of the analytical methods available and used at a given time.

Lesson
Sampling must be thorough and widespread and follow well-developed standard operating procedures that incorporate good sampling practices. Sampling including all items and relevant utilities on site is recommended, preferably based on information for optimum sampling points from the manufacturer.

A limited sampling strategy focusing on only few sampling points risks missing relevant information and thus is counterproductive. Sampling can be a two-edged sword: While positive samples are strong forensic evidence, negative samples may easily lead to false or wrong conclusions. "The absence of evidence is ***not*** *the evidence of absence" and this is particularly true for samples from a facility that has been subject to thorough cleansing and decontamination.*

As part of any standard operating procedures for sampling, the analysis of the samples should be performed by more than one certified laboratory to ensure the highest quality

of results. Thus, a network of outside analytical laboratories has to be established.

Because of rapid technological progress in the area of sample analysis, it is recommended that sample aliquots be archived under appropriate storage conditions for 15 years.

Results from analysis of samples have to be carefully assessed. They will always carry the notion of "scientific" evidence, and will thus have a strong influence on decision-making.

Inspection Reporting

"If it is not written down, it did not happen", this was the motto that the UN inspection agencies lived by and one that proved essential. The summary of all inspection activities and any ancillary incidents together with lists of imagery taken, samples collected, documentation handed to inspectors and any other material were together incorporated into an inspection report. Like any report, the quality reflected the various inputs of team members and the writing skills of those charged with the task.

For disarmament inspection under UNSCOM, team members were often only given a day or two once moved to Bahrain to assemble the final report. Even with a dedicated report writer this proved a difficult and sometimes almost an impossible task. The report was meant to remain as a whole (together with attachments) although this failed to be the case in several instances. Sometimes reports were not specific enough as to judge exactly the details of events as described or incidents were omitted.

In addition, each chief inspector had his or her particular writing style and hence the value and quality of inspection reports, although generally of a high standard, did vary. UNMOVIC attempted to address these problems by introducing a reporting format which should have encouraged consistency in style and information presented and it would have also been easier to include into UNMOVIC's data base holdings. Although promising in theory, UNMOVIC was in the field for too short a time to say whether this innovation would have been a help or a hindrance.

Lesson

It is essential to record accurately, precisely and unambiguously the results of an inspection. Having other supplementary supporting information such as video, hand-held still photography, audio recordings should also be an integral part of the report. Omitting details or incidents will mean in fact that if it is not written down or recorded, such an incident did not happen. Committing to memory can be a dangerous practice as memories are subject to fading or being confused and personnel with those particular memories are sometimes lost to the system.

Consistency in writing style is helpful but having a dedicated report writer for short-term missions is essential. It was important to finalise the reports before the team dispersed and while the inspection was still fresh in the inspector's minds. Having a standardised report-writing format could prove useful.

Keeping all of the inspection reports together in one folder is also an essential. Sampling results that may not be available until some time after the conclusion of the inspection itself must be incorporated into the report and stored in one place. Some of the UN inspection reports that were fragmented have remained so.

Multi-tool approach

Besides a multidisciplinary approach to inspections, the UN inspections organizations learnt that several inspection tools and techniques had to be applied simultaneously to specific areas of investigation. For example, the VX experience showed that only a sophisticated verification system comprising various verification tools and techniques (see Table VIII.II) in combination with on-site inspections was capable of uncovering indisputable evidence of undeclared activities.

Table VIII.II. Verifications tools and techniques that, in combination with on-site inspections, exposed undeclared activities related to VX.

Tool or Technique	Effect/Result
Verification of procurement data	Revealed the acquisition of large quantities of precursors by Iraq
Information from former suppliers	Helped to corroborate the procurement data
Document searches	Resulted in the discovery of some records on VX-related activities
Interviews with Iraqi scientists and technicians	Helped to identify gaps in Iraq's declarations on VX
Debriefings of defectors	Produced additional information on the weaponization of VX
Sampling and analysis	Identified the presence of VX degradation products

The multi-tool approach was also effective in achieving monitoring goals, as learned from the experience of ongoing monitoring and verification in the missile area. An enhanced verification system comprising several tools and techniques (such as on-site inspections, static and flight test observations, use of remote cameras, documents and computer searches, tagging of missile hardware in combination with an export/import monitoring mechanism, and restrictions on the reuse of missile parts and components from other permitted-range missiles) in operation simultaneously helped to deter prohibited activity while inspectors were present in Iraq.

Advanced technologies for inspection

Sensors, and Remote Monitoring Cameras

UN inspectors used portable chemical detectors as a safety tool as well as for investigative purposes. Although the reading on the sensors became a signal to take appropriate precautions, in most instances it did not translate into the presence of a CW agent.

Cameras were installed at several facilities in Iraq that were judged to have either specific dual-use equipment or were involved in activities that could be easily diverted to proscribed purposes. Although the camera system worked well, there were a few

problems especially initially with the location of the cameras themselves. In some cases bright sunlight blinded the camera at certain times of the day, dust covered the lens, the local electricity power supplies was unreliable (which meant no lighting for a room at night) and the intense heat during the day meant that the signals could not be relayed from certain locations.

While the camera systems generally worked well, the usefulness of the information received varied between locations and disciplines. Camera monitoring of vehicular traffic entering or leaving a facility gave some idea of activity at that site, but often where a camera was focused on a piece of equipment, Iraq avoided using that equipment. The camera system helped during some inspections to see if Iraq was preparing for an inspection ahead of time and to note unusual activity: cameras were also useful during the times when Iraq evacuated some equipment when anticipating a military strike. In addition the presence of a camera system was in itself, probably a deterrent to any illicit activity.

Geophysical equipment - Ground-penetrating radar

UNMOVIC inspectors, and those of UNSCOM before it, had at their disposal advanced geophysical equipment for the search of hidden structures and storage spaces that could be used for hiding precursors, agents or WMD. Of special interest was the capability of those technologies to detect concealed spaces and passages that could be used for storage, laboratories or production facilities nearby or under large buildings, such as factories, hospitals, and military installations. This equipment was used to validate other findings and provide objective data during an inspection. Although nothing of significance was found during the UNMOVIC inspection period, the tool was valuable in checking information supplied by supporting governments with regard to underground facilities.

Remote drilling and sampling of munitions

MONICA, the remote drilling and sampling equipment used for inspecting intact but dated chemical and biological munitions in Iraq, was first trialled in the field by UNMOVIC. Being a novel piece of equipment, some refinements were made as a result of experience in the field. With these improvements incorporated into the design, this equipment worked very well and allowed for the safe drilling and sampling of munitions. A specialised team of trained munitions experts were charged with the operations of MONICA, while a specialist sampling team was responsible for the handing of all samples taken.

Computer and server forensics

In order to inspect the computer files and disks of data at certain locations in Iraq, UN inspectors included specialist computer forensic analysts in the inspection teams. These specialists accessed computers and down loaded data and information which was analysed back in the Canal Hotel. The computer searching was done on the basis of key words and phrases. Some useful information came to light through these methods of investigation especially in relation to acquisitions for the Iraqi missile programme.

Lesson
Chemical detectors are an essential component of the safety equipment but it takes experience to judge whether the reading reflects the presence of a CW agent or whether it reflects the presence of an industrial chemical. Many wrong conclusions can be generated from positive signals.

The camera system as operated by UN inspectors for remote 24 hour a day monitoring provided some useful information but cameras were not always installed in the best positions and it took considerable time and manpower to review this information. Cameras at the missile sites seemed more useful and at biological sites less so.

Other devices used in the field such as ground penetrating radar and computer forensics proved useful at times but also proved time and resources demanding requiring specialist teams. Much could be searched and inspected with few results however the circumstances operating in Iraq at that time required such measures. The computer forensics depended heavily both on key word searches and on available translators and this proved a bottleneck. The ground penetrating radar capability would normally only be used sparingly and not as part of a routine inspection.

MONICA proved a very valuable tool in the field and was an excellent device for remotely drilling and sampling munitions. Having MONICA was a lesson in what to do right. It allowed for the safe exploitation of critical data in chemical and biological munitions.

Information requested and sources

Declaration of WMD programmes

Under Security Council resolution 687 (1991) Iraq was obliged to provide data relating to its past WMD related activities. During the 1990s, Iraq made several disclosures regarding its past WMD programmes in the form of Full, Final and Complete Reports (FFCR) or Disclosures (FFCDs), and in December 2002, it compiled a Currently Accurate Full and Complete Declaration (CAFCD) for its CBW and missile programmes.

Iraq made several types of declarations or notifications:

- Declarations for WMD programmes (FFCR, FFCDs, CAFCD)
- Semi-annual declarations for sites under monitoring, and
- Declaration and notifications for import of dual-use equipment and materials under the Export/Import Mechanism (SCR 1051).

These declarations constituted the basis for disarmament activities. The early declarations (supplemented by numerous letters and correspondence at the senior Minister level), supplied by Iraq were scant and incomplete and often contained either false or misleading information.

However, after the defection of Lt. General Hussein Kamel in 1995, the FFCDs contained much more detail and were voluminous. While providing a substantial amount of information in these declarations, Iraq stated that because of the destruction of documentation, some information was supplied from memory, best guesses or from back calculations. This was accepted with doubt by UN inspectors who were desirous of more precision and accuracy in the information supplied.

With UN inspectors' knowledge as of mid 2007, it seems that much of the material in the later (post-1995) declarations was accurate although there were a few exceptions. For example, some specific details supplied in the 2002 CAFCD were not entirely accurate as shown by the declaration relating to the destruction of biological agent: only when interviewed by the ISG in 2004 did Iraqi scientists admit that bulk biological warfare agent was destroyed at a location not before declared by Iraq.

Declaration of facilities under monitoring, semi-annual declarations

For monitoring purposes, Iraq was requested to submit semi-annual declarations for specific sites, either those involved in the past WMD programmes or those having a dual-use capability. In addition, Iraq also supplied specific information as requested on particular issues.

The criteria used by UN inspectors for requesting semi-annual declarations for monitoring purposes changed in the period after its introduction in 1994 as the UN inspection body was more able to refine requirements. As the declaration format and method was a novel experience for both the UN inspectors and Iraq, adjustments were necessary over time. When collecting information there is a tendency to collect everything whether relevant or not with a "just in case" mentality being the governing factor and based also on the premise that it is easier to discard information than to go back and collect it. The result of such conventional wisdom was that much information was collected and never used. It put an unnecessary burden on both the agency supplying the data as well as the UN inspectors who had to log and file the data even if analysis was not done.

Lesson
The use of vague and ambiguous wording in declaration formats leads to inaccurate, vague and ambiguous data supplied. Not only did such vague wording (such as "capable of being modified") cause confusion to Iraq, it also caused debate and confusion among UN inspectors.

In order to improve the current declaration formats UNMOVIC has tried to remove ambiguities and to provide definitions as to what to include and what not to include, on a scientific and technical basis and with appropriateness, applicability and logic in mind. The proposed Biological Declaration Format is shown in Table VIII.II as an example. One important lesson is that information requested in the form of declarations should be limited in volume and focused on key points, to avoid overloading of the verification and monitoring system.

The "vacuum cleaner" approach to data collection although understandable particularly early on in an inspection process, placed undue strain on both the collector and those supplying the information. Volumes of data in minute detail were time and resource draining and few UN inspectors became experts on the declarations. However, some of the information in the declarations was checked for consistency both between years and with the reported activity of the site and therefore was a useful monitoring tool.

Perhaps one of the spin-offs from the requirement to complete the declaration data was that Iraq was forced to implement a system of data collection, which meant that such data was available for its own decision-making.

Requests for information in the form of declarations should be based on threat assessment, and a correct and relevant technology assessment.

The requested information should be focused on key points, and multiple-way catch of critical elements.

The declaration system should be transparent, to avoid uncertainties regarding what to declare or not.

The lists of relevant dual-use items and materials to be declared under a site monitoring plan (associated with site declarations), and an export/import monitoring mechanism have to be synchronized in order to ensure coherence and avoid ambiguities.

Table VIII.II. Criteria for declaration of site and facilities, biology

Criteria for site or facility declaration				Criteria for listing of equipment	Criteria for listing of agents
Site/ Facility	**Activities**	**Equipment**	**Inter-national transfer**		
# high or maximum containment for work with human and animal pathogens # containment for working with plant diseases, # containment for producing micro-organisms using embryonated eggs	# possession, storage, destruction and work with listed agents, # any activity involving genetic modification of a listed agent or transfer of genetic elements from a listed agent, # any activities involving the breeding of vectors of human, animal, or plant diseases, or pests, # activities involving micro-encapsulation of live micro-organisms or proteinaceous substances, # bio-defence activities, # any activities involving vaccination of humans against botulism, smallpox, or anthrax	# possession of listed equipment	# transfer of listed agents and equipment	# a 'choke point' (critical and non-replaceable equipment for a process or a specific use # transparency i.e. readily identifiable item # practicable i.e. high signal to noise ratio, # complementary to SCR 1051 list	# biological agents and toxins known to have been part of a former BW programme, # biological agents and toxins known to have been effectively weaponized, # biological agents and toxins known to have been subject to effective attempts to weaponize, # biological agents and toxins having properties for being relatively easy to weaponize

Procurement information

Procurement data is a combination of the information, documents and records relating to specific actions taken for the acquisition of items and materials. They include:

- communications and negotiations with prospective suppliers,
- notes of meetings to discuss requirements,
- tenders describing services required and items and relevant specifications,
- offers made by suppliers, and
- the preparation and implementation of contracts, including insurance documents, bills of lading, transshipment information, customs documentation and final delivery certifications of contract implementation by end-users.

Procurement information is also available through financial statements, such as the opening of operational accounts in corresponding banks issuing letters of credit and a variety of money transfers from the accounts of end-users to banks involved in the transactions.

In the course of investigation and verification by UN inspectors, it was established that in the period from the mid-1970s to 1990, more than 200 foreign suppliers had provided major critical technology, equipment, items and materials that were directly used by Iraq for its CW, BW, and missile programmes. About 80 branches of foreign banks outside of Iraq were involved in transactions related to those acquisitions. In addition, dozens of trans-shipment companies were involved in the delivery of items and materials to Iraq.

Given the critical role that dual-use technology, equipment and materials acquired from foreign suppliers played in Iraq's development of its weapons of mass destruction programmes, the evaluation of procurement data proved to be one of the major tools for the investigation, mapping and verification of Iraq's declarations concerning such programmes. The UN verification experience in Iraq shows that despite Iraq's extensive concealment policy and practices, it was still possible to find evidence of its procurement activity. Multiple "fingerprints" of past acquisitions existed not only at various organizations in Iraq, including ministries and agencies, establishments and banks, but also outside Iraq, in countries of suppliers and third countries through which goods were trans-shipped.

Lesson

The nature of the procurement process was such that multiple "fingerprints" of past acquisitions exist. These fingerprints could not be concealed by Iraq and proved valuable avenues of enquiry.

Early direct contact to international suppliers of critical material may contribute significantly to the inspection efforts.

Information supplied by cooperating Governments

When investigating Iraq's WMD programmes prior to 1991, information supplied by cooperating governments proved invaluable especially in the early years of the inspection process. UN inspectors were supplied with data related to sites, facilities, some personnel and activities prior to the individual inspections commencing. Most of the information was historic in nature and assisted the planning of the inspections.

Governments passed on in good faith information thought to be of value although in many of the chemical, biological or missile areas, little was known with certainty. Some information particularly that derived from imagery analysis was unique and useful even if a little dated. With regard to other information supplied from governments, some was derived from company activity within their own country, defectors or assessments made from information collected by their various organisations.

The information was not taken as fact and at face value but was scrutinised and checked against other information held. Because UN inspectors had access to this government – supplied data but not the source itself, due care was exercised before acting on such information. In some instances, the information was very accurate and provided very valuable in forcing Iraq to disclose more (for example information supplied by a supporting government with regard to the imports of growth media used in Iraq's BW programme) in other case, information was misleading, wrong or outdated (that supplied by "Curveball").

Even when information was accurate, there remained the problem of currency. By the time imagery was taken or a defector debriefed, the data analysed and passed onto to UN inspectors, weeks or months could have elapsed. While in some cases this was not a great problem (if for example it related to construction at a site) in other instances the information supplied was not actionable.

When UN activity became routine in Iraq after the first year or so of operation, UN inspectors with their first hand experience and knowledge, relied less on information passed to them by governments. UN inspectors knew most sites and associated facilities, personnel and capabilities and in more detail than information supplied from outside.

Lesson
An important lesson learned by the UN inspection agencies was that information supplied by cooperating governments and in good faith was often dated and was not actionable information for current operations. In addition, as could be expected, some information was inaccurate.

This importance of timing was crucial to the short-lived UNMOVIC inspections given the international atmosphere prior to the military action in March 2003. More timely and accurate information was available from within the inspection agency than from outside suppliers.

The UN's verification experience in Iraq illustrates that in-country verification especially

on-site inspections generate more timely and accurate information than outside sources.

Open Source

Information contained in the open source media, which includes reports and articles in journals and magazines, newspapers, radio and television has increased enormously since the introduction of the internet. While there is a wealth of data and some of this also from unique sources (for example, reporters who are in country with privileged access) such enormous data quantities have to be scrutinised and treated with caution. Much of the open-source data relating to Iraq's past WMD programmes proved to be false or misleading, was slanted, without substantiation or was misinformation.

Nevertheless, open source reporting was used both to judge the intention of the regime (through local newspapers and media statements) and to follow leads regarding possible locations of WMD-related items. Just prior to the short period of inspections by UNMOVIC and with a war imminent, media interest was at a crescendo. This in turn meant a very high profile for statements made by defectors and other sources who claimed certain facilities were still being used to produce WMD and claims were made regarding the existence of underground and mobile biological warfare agent production facilities. Some of these claims were followed-up by Iraq showing the media a particular facility (such as the FMDV plant at Dora) to disprove the claims. UN inspectors were obliged to also inspect these facilities and did so finding the claims groundless.

Lesson
Although open source information can be valuable and unique, all information should be treated with suspicion. Well-placed defectors presented information, which was incorrect or misleading and certain other open source reports were slanted.

Destruction of weapons, equipment, materials, and agents

The lessons learned from the destruction process of WMD-related items are also discussed in more detail under the separate discipline headings.

Unilateral destruction

The verification experience of the Special Commission and UNMOVIC shows that in the absence of physical evidence, a country's documentation of its weapon programmes is critical for verification. The intentional elimination or concealment of documentary evidence dramatically decreases confidence in the inspected party and leads to ambiguities that may never be resolved satisfactorily.

Given the absence of complete production, storage and deployment records, which according to Iraq were destroyed unilaterally, it was not possible for United Nations inspectors to verify fully the Iraqi declarations regarding overall quantities of biological and chemical weapons produced, used or retained. Verification of the declarations was made even more difficult in the CW area, since the major part of the bulk chemical warfare agents produced and chemical munitions filled over the period of 10 years had

been used in combat. Similar problems were encountered in the missile area with the unilateral destruction of Scud systems and warheads.

The main lesson for the UN inspectors was that unilateral destruction implied continued uncertainty about at least some aspects of the past programmes. No amount of alternative information from outside suppliers, interview evidence, sampling or even excavations or other sources was sufficient to confirm all aspects of Iraq's declarations. In the case of the R-400A biological bombs where Iraq provided substantial documentary evidence and excavated the declared destruction site with promising results, although there was qualitative evidence to support Iraq's statements, there was no similar quantitative evidence and hence a residue of uncertainty remained: in this case perhaps a very small residue. The result of the unilateral destruction was a prolonged and complicated inspection regime for Iraq, perhaps a lesson for them as well.

Lesson
Perhaps the inclusion in resolution 687 of specific additional punitive measures, that would follow from not adhering to all the conditions laid down for the process of disarmament, might have prevented the unilateral destruction of WMD-related items from taking place and thus avoided the complications that resulted. Unilateral destruction made it almost impossible for the UN inspection Commission to be confident in verifying all aspects of Iraq's declarations.

Destruction under UN supervision

The UN inspection agencies learned some valuable lessons regarding destruction or rendering harmless of prohibited items under its supervision. In a few instances, Iraq was able to remake or repair the damage to items that occurred under UN supervision: items that the UN inspectors thought were either rendered harmless or destroyed. For example, Iraq cut a V shape in a missile propellant mixing bowl and two casting chambers rendering them harmless. However, Iraq was later able to re-weld a piece of metal into the bowl and chambers so as to be able to use them again.

In the chemical area the process of rendering harmless leaking and damaged chemical-filled munitions too dangerous to be moved, by entombing seemed the most sensible and logical approach to disarmament. As long as the entombments were subject to UN monitoring, the policy worked well. However, since March 2003 when UN inspectors were withdrawn from Iraq, breaches to some external walls entombing these leaking and damaged munitions occurred. This casts some doubt on this method of rendering harmless.

In the biological area, although detailed descriptions and imagery was taken of equipment at Al Hakam prior to its destruction, there was no attempt to sample the media in containers before destruction. Taking random samples would have shown whether the media destroyed was indeed as marked on the container.

Lesson
With regard to destruction, when prohibited equipment is subject to destruction or being rendered harmless, it should be irreversibly destroyed. The destruction process should be well thought through and all pertinent information on items to be destroyed should be recorded. Rather than destroy munitions under a false sense of urgency, in many cases munitions or WMD related equipment could have been placed in sealed storage and destroyed later only when all relevant verification-related information had been collected.

LESSONS LEARNED - CHEMICAL WEAPONS

Destruction

One of the main priorities of the UN Special Commission was to destroy, remove or render harmless chemical munitions, bulk agent, precursors and relevant equipment and infrastructure. Under the instruction that the destruction of chemical munitions was a very high priority, UN inspectors set about to supervise the destruction of as many chemical weapons and bulk agent as quickly as possible while taking appropriate safety and environmental precautions. In the early days of the inspection and destruction process, UN inspectors were unaware of the extent of Iraq's biological weapons programme and therefore when presented with a biological munition that Iraq claimed to be a chemical munition, this was accepted unchallenged. Although questions were asked by UN inspectors about certain markings on bombs for instance, when told this was just for special chemical agents and there was no grounds for thinking otherwise at the time.

Many empty bombs were presented for destruction at Muthanna in September 1991 and were destroyed without recording the details relating to bomb markings and numbering. Some of these bombs later turned out to be designated for a biological agent fill. As UN inspectors had not taken appropriate imagery of every bomb destroyed or noted the markings and numberings on each bomb, a request had to be made to Iraq later to provide video imagery to allow UN inspectors to verify numbers of empty biological bombs destroyed.

Lesson: Record all identifying features before destruction – requirements change
What seemed a straightforward exercise of supervising the destruction of empty munitions became more complicated later when Iraq declared its offensive BW programme. Once the munitions were destroyed (and only counted by type of bomb) it was almost impossible to go back and verify markings and numberings. There was no request for UN inspectors to do anymore than supervise destruction at the time but requirements changed. Less haste with the destruction and a full inventory, even if more time consuming then would have been valuable in hindsight.

UN experts did form a specialized team called the Chemical Destruction Group (CDG) that operated from 1992 to 1994. This was a good move even in hindsight. The CDG was based at Muthanna and followed rigorous practices in designating areas for chemical destruction (regardless of method of destruction), methods for transporting munitions to the destruction area and methods of destruction while ensuring minimal risk to health and to the environment. The UN consulted countries with the expertise in disposing of chemical munitions to make sure the best possible methods were implemented.

Lesson: Doing it Right
The establishment of a specialized group responsible for supervising the destruction of chemical weapons, agent and precursors was the right move. Destruction of chemical weapons requires expertise and experience that is not widely available.

The destruction of chemical munitions was done according to best practices and local circumstances. When safe to do so, munitions were brought to Muthanna State Establishment: a central location was selected for neutralization or destruction of chemical agent before disposal of the munitions casing. Some munitions deemed too dangerous to move were destroyed on-site by explosive methods or in one instance, were entombed in a storage bunker in MSE. These entombed chemical munitions included 122mm rockets filled with sarin which were damaged during bombardment. Some precursor chemicals and their degradation products or remnants from the destruction process were also entombed in that bunker; others were placed in a number of underground structures. At the time, this was a logical move. Many precautions were taken to render the munitions harmless by sealing them in a reinforced concrete tomb. As long as this site was monitored and guarded there was no problem. However, in hindsight, some problems and concerns which occurred post March 2003 could have been avoided if there had been total destruction of these munitions at the time, even if this would have been a slow process and involved some risks.

Lesson: Render Harmless - make the destruction final
What seemed at the time the most logical way of dealing with leaking and unstable munitions by entombing them in reinforced concrete bunkers and sealing the bunkers, raised concerns when circumstances changed later. Post March 2003 some bunkers were breached and questions were raised about the viability of any munitions or chemicals entombed.

The destruction policy relating to chemical munitions and related items was clear and precise. However, with regard to dual-use materials and equipment with the approval of the Executive Chairman, some items could be released to Iraq for civilian use upon request. Such items would be monitored. The criteria for which dual-use items qualified for release did not always appear clear to UN inspectors.

In general, the practice adopted by UN inspectors was to destroy any dual-use equipment or materials that was either used or purchased for use for the proscribed programme. So dual-use chemicals that were bought specifically for the CW programme were destroyed while sometimes large quantities of the same chemicals were in abundant supply throughout the country. The same principles applied to dual-use equipment. In order to avoid the destruction of material and equipment that could be used for civilian purposes, Iraq embarked on a strategy of moving, denying or masking many items.

Lesson: Develop a logical destruction policy early
There must be consistent and unambiguous guidelines to any destruction programme and such a policy should be articulated before the destruction begins.

Structure of Iraq's Chemical Weapons Programme

Qualified personnel

Qualified scientists and engineers were a limiting factor in Iraq's CW weapons programme. Some examples:

- During the entire period of the chemical weapons research programme (mid-1970's to 1990), none of the critical chemical weapons precursor research programmes yielded products of sufficient or desired purity at an industrial level. By 1990, the only high-purity industrially produced compound was choline. To a certain extent, the Iraqis were able to produce most of the precursor compounds in the laboratory, but failed to produce them in bulk, even with batch-based process engineering. This failure meant that Iraq had to procure precursor chemicals that should have been available from the purpose-built plants in Iraq.

- Furthermore, the only Iraqi chemical agent production programme that yielded a stable agent with a high degree of purity was sulfur mustard. In contrast, tabun, sarin and cyclosarin produced by Iraq were only in purities of approximately 40-60%, and were then rapidly (weeks) taken to the battlefield and used. VX production was attempted on a comparatively smaller scale, and no conclusive evidence was discovered that VX was used on the battlefield.[4] The VX produced degraded too fast for it to be stored for a long period of time. Iraq's VX in reality was a post-reaction liquor and the other compounds in the reaction mixture caused the decomposition of the VX over the course of several days to several weeks. Iraqi engineers, aware of this, conducted research to solve this problem in the period following the Iran-Iraq war, but this effort was reported to have failed.

Although fully operational and capable, in 1990 MSE was suffering from shortages of some precursors needed for nerve agent production, namely MPC and its precursors: DMMP and TMP, a starting material for DMMP. Iraq did have however another technology path for MPC production using imported PCl_3 as the initial chemical. UNMOVIC estimates that Iraq could have achieved basic self-sufficiency in precursor production in couple of more years despite difficulties of acquiring dual-use materials, equipment and technologies.

The failure to produce high purity agents and precursors occurred despite the fact that expert engineers from foreign countries constructed a large number of turnkey plants that were capable of being used to produce CW precursors or related compounds (but not specifically designed for this purpose). Iraqi personnel were not able to successfully reconfigure the plants for CW purposes. Money and other material resources were not the impediment to the programme. Rather, it was the people necessary to run such a programme.

[4] In the Iraq Survey Group Report of March 2005, interview testimony claimed that three aerial bombs were used.

Even though the Iraqi government spent millions of dollars on funding for its tabun programme, the project was plagued by low yields, low purity, and high degradation rates of its impure products. Many low purity problems could have been ameliorated by more efficient temperature control, a change in stoichiometry or additional reactants, more appropriate filtration or distillation equipment, or simply the knowledge of how to use these components in the manner for which they were designed.

Repeatedly, a small group of very intelligent scientists and engineers were designated to work with unskilled and inexperienced laborers to build and run factories at great cost. Although academically many of the chemical engineers were well qualified, they appeared to have lacked appropriate experience.

Lesson: Money alone is not the answer, it's the right people that count

Iraq had good R&D staff but this did not guarantee good industrial efficiency. Qualified scientists and engineers would have been required at all levels of production process.

Even when money is not a problem, there is no substitute for engineering experience when running a chemical production plant. It seems clear that the chemical programme achieved limited results not because of a lack of materials, finance or equipment, but rather, a lack of applied knowledge on how to run the chemical process concerned.

Significant experience and industrial capability is needed to produce high purity nerve agents; only the most diverse, industrialized nations have that potential. Unlike mustard, which is relatively simple to produce, nerve agents require multiple synthetic and purification steps. No amount of stabilizers used to preserve nerve agent can compensate for a lack of product purity. Therefore, a potential proliferator must either seek assistance on how to manufacture certain dual-use compounds indigenously (not forbidden by any treaty, including the CWC), or procure them directly from a producer who will circumvent national legislation to do so.

Lesson: Watch for Joint Ventures
A national-level chemical weapon proliferant would likely seek out qualified foreign assistance under the guise of legitimate commercial ventures. The procurement links may reveal the cover story for illicit activities.

Production processes in general

Iraq's CW programme was focused largely on satisfying the immediate needs of the military. The Iraqi mustard programme employed relatively inexpensive chlorination chemicals to chlorinate thiodiglycol. Nevertheless, the chlorination process that was adopted was not the most cost effective method. Rather, the method chosen was the easiest - a one-step synthesis with easy purification that depended on imported materials.

The sarin programme was geared towards producing agent in volume to satisfy an immediate need: this meant that the stabilization of sarin, as well as its purification was of secondary importance.

In the case of VX, it is difficult to have conclusive proof, since the actual work done is listed only in declarations. However, it appears that this multi-step synthesis was performed to obtain the purest possible product, using the fewest steps that had the simplest purification procedures regardless of the fact that these procedures sometimes needed far more reactant than was necessary.

Lesson: Look for Simple Methods not Best Results
In order to produce at least some results, CW agents were produced in Iraq using the simplest methods that utilized the materials available; cost effectiveness, efficiency or yield was a lesser priority.

The essential "technological discipline" required for high quality and long-term storage includes:

- Constructing a purpose-designed production process (not trying to adapt a production process not well suited to the specifics)
- Fine tuning (optimization) the production plants for a specific agent production (rather than experimenting during production runs)
- Strict quality control based on proven and reliable analytical techniques (rather than an ad hoc approach to quality control).

Since low quality agents were able to satisfy urgent (transitory) military needs, in this case some shortcuts in the production process were acceptable. Although Iraq failed to produce sarin and cyclosarin of a high purity mainly because of insufficient analytical support, it is likely that given some time (maybe a year or so) Iraq might have been able to overcome these problems.

The "Iraqi binary" concept applied to its CW production in 1990 proved to be a simple working remedy for low quality nerve agents and/or their longer term storage. On the other hand it may be indirect proof that Iraq's research on and tests with real binary systems did not succeed by the end of 1990.

In addition, it appears likely that some reports emanating from MSE were either exaggerated or misleading (for example, statements regarding achievement awards for MSE in 1987[5] or "binary" munitions).

Lesson: No technological discipline, no gain
Since the bulk of unitary agent produced and filled in 1990 was of quality comparable to 1988, this can again be an indication that Iraq's CW research and production techniques made no significant achievements in the post-war (Iraq-Iran) period.

[5] UNSCOM Doc No 700050 and Technical Evaluation Meeting on VX

Iraq learned some important lessons in respect to the use of CW, both on tactical and strategic level. Tactically, CW played the role of multiplier for conventional efforts and allowed Iraq to withstand Iran's "human waves" attacks or, in general, to compensate for its shortages of human resources. In addition, at a strategic level, Iraq learned how important the psychological impact of the CW use was on the outcome of the war. It became an influential factor for Iraq to continue its CW programme.

When the war with Iran ended, Iraq had the opportunity to deal with problems and in its CW agent production and weapon capabilities. In addressing these issues, Iraq undertook the following steps:

A. In the field of CW:

- Conducting research on new chemical warfare agents with VX as primary choice
- Optimization of production technology for previously produced agents in order to increase their stability, purity and storability
- Preparation of production technology for key CW precursors and raw materials
- Establishing alternative chemical facilities (beyond MSE) ready to launch CW production when needed
- Development of new types of chemical munitions, mainly binary systems and long-range delivery means.

B. In the field of commercial production:

- To produce basic chemicals important for civilian industry but also useful for CW precursor manufacture (e.g.POCl3, PCl3, TMP, Chlorine, Fluorine containing compounds, elemental phosphorus)
- Construction of multipurpose facilities for the production of the commercial chemicals that could be used for CW production if needed.
- Use of CW plants at MSE to produce civilian goods taking advantage of their capabilities in order to generate income for current activities and keep them running and maintained
- Engage its CW experts in work of civilian chemical facilities e.g. agricultural and pharmaceutical using their knowledge and experience for boosting chemical industry and preserving the potential they constituted

In general, Iraq was heading toward the establishment of long-term CW capabilities based mostly on the raw materials locally available. Thus, Iraq procured and installed the production plant for PCl_3 that is crucial precursor for all nerve agents, as well as for commercial chemicals such as pesticides, and polymers including flame-retardants.

The MSE R&D centre was researching production methods for CW precursors that would allow Iraq to avoid the procurement of dual-use chemicals banned by that time internationally (MPS production through the elementary sulphur, thiocholine production through thiourea, MPC production through pyrophosphates). As mentioned by the MSE scientists in the interview to the UN inspection team, they considered that in terms of the CW programme, priority should be given to the production of good quality stable MPC that then "will give the flexibility in terms of both V and G agents".

Priorities in the CW programme were reshuffled from production into research and development aimed on particular issues to overcome existing shortages and weaknesses for example, selecting better stabilizers, solvents or purification methods. Although Iraq claimed there had been no long-term plans, work was conducted in all these fields

Most of the efforts and resources were spent on both unitary and binary nerve-agent development. Among them VX was given the highest priority. Less attention was given to mustard that did not require continued development efforts because the process adopted by Iraq was relatively simple and its quality had already reached the highest level.

Lesson: Success breeds further efforts

The end of the war with Iran did not mean the end of Iraq's interest in CW, and the role of CW in Iraq's military doctrine in the post-war situation required new developments in many areas including chemical agents and means of their delivery. In general, Iraq was heading toward the establishment of long-term CW capabilities based mostly on raw materials locally available.

Equipment

In a wartime situation, Iraq accepted the lower efficiencies of the CW agents and lower safety standards resulting from equipment deficiencies.

Chemical warfare agents differ in their sensitivity to the variations in their production parameters. For example, mustard production is far more robust and forgiving to variations in its production parameters than VX, and this means that it is much easier for a higher quality of mustard to be produced using less than optimal production parameters.

Faced with strict international trade controls, Iraq looked to either circumvent these controls or find an indigenous alternative. Iraq tried with limited success to develop indigenous alternatives for its main chemical precursors.

Lesson: Necessity drives standards

Iraq compensated for the lack of access to certain equipment by using what was available but this was done at a price of efficiencies and safety as well as product quality.

CS is a commonly used, non-lethal, riot control agent that is intended to temporarily disorient and subdue. Because of the nature of CS, its widespread use as a riot control agent and the uncertainty as to whether this could be considered as a CW agent and therefore part of Iraq's WMD programme, Iraq's CS was not given sufficient attention by UN verification and monitoring activities in the period 1991 to 2003. Thus, a more detailed understanding of CS was not undertaken, and many questions and uncertainties arise and remain as to:

a) **Iraq's production of CS.** It seems likely that the quantities of CS produced are understated. There is no clarified information on production of CS at the Al Salman site in 1981 and some doubts remain about the full extent of cooperative work between MSE and TRC with respect to mixing CS with the biological agent aflatoxin.
b) **Filling of 250kg and 500kg bombs with CS.** Based on the physical properties of CS, **t**here seems little rationale or military benefit in filling 250kg and 500kg aerial bombs with CS unless it is used to mask the effects of other chemical agents. If there were other reasons then these were not provided to the UN.
c) **UN inspector's lack of finding CS filled munitions.** It should be noted that, apart from a single CS filled grenade, UN inspectors did not find any CS filled munitions, whole or destroyed, in Iraq. No remnants of the destroyed CS filled aerial bombs were found.
d) **Sampling and analysis of CS.** Many samples of CS from the R&D site, production site, filling site and storage site and were analysed by Iraq using HPLC, IR, UV, and CNH analysis from 1980 to 1990.[6] However there are no records of analysis in declarations or in Iraqi documents.

Because of the limited information available, it is likely that answers will remain illusive.

The analysis of Iraq's CS programme seems to indicate that some, if not most elements, of this programme were not declared by Iraq. It is possible that the CS programme was more extensive or complicated than declared or was used partially to disguise other programmes or elements of programmes.

Lesson: Do not downplay riot agents e.g. CS
Despite the classification of CS as riot control agent it was widely used by Iraq for military purposes. Iraq declared that CS was weaponised and delivered by artillery and aircraft. Iraq was not only able to produce quantities of CS to be used as a unitary agent it also experimented with combining CS with a biological agent. Even when the Iran/Iraq war ended in 1988, Iraq continued its work with CS until 1990. It appears that, based on its experience during that war, Iraq considered this agent a prospective warfare agent.

Lesson

During the verification and monitoring activities, all elements of a CW programme have to be surveyed and the interconnecting relationships identified. Only then is it possible to minimize the ambiguities in the inspection process.

Tabun and Sarin

Tabun may be a first step into nerve agent production. When embarking on its chemical agent programme, Iraq started with production of tabun before progressing to more complex and more lethal agents later. Iraq had some familiarity with producing CS and mustard prior to tabun production. However since tabun was the simplest of the nerve agents to synthesize, it was no surprise that Iraq chose to produce this agent while it was

[6] Chemical CAFCD December 2002, Chapter IV para 4.13

accumulating knowledge and expertise for the production of sarin and later still VX. Although sarin was also researched at this time, and entered into production shortly afterwards, tabun was already in multi-tonne production before sarin synthetic pathways were finalized for production. VX was not attempted until these simpler-to-produce agents were perceived to be successfully produced.

Lesson: The development pathway might be country specific
Iraq followed a historical order for the development of nerve agents. However this does not have to be necessarily repeated by potential proliferators. Organo-phosphorous containing compounds should be accorded special attention.

VX

Although it is hard to arrive to any final conclusions on the extent of the VX production activities conducted in the past some observations can be made.

As seen from the Haidar Farm documents, declarations and interviews, Iraq began to scale-up its VX production processes at the end of 1987. It had chosen route A[7] at the beginning and then switched to the simplified 'direct' method of production – route B. The MSE personnel (scientists and engineers) were not able to master the process via route A (at least at the end of 1987 – beginning 1988). The possible reasons for that included: impurities in the primary precursors (MPS and monoester), problems with the control of the reaction temperature or problems with the purification of the final product by distillation.

Less selective, route B gave Iraq a less pure intermediate product called "Dibis" that could be stable for months and could be converted into free VX via a one step procedure when needed. Iraq was unable to explain to the Commission in technical terms why the "Dibis" produced in April of 1990 by route B was of low purity and deteriorated so fast within two days.

In the post Iran-Iraq war period, MSE tried to develop two alternate routes for VX production (routes D and C) that theoretically could give stable unitary and binary VX of high purity (more than 90%). The extent of these efforts could not be verified by the UN Commission due to the lack of the available documentation, especially for the period 1989-1990.

Based on the data available, it appears that MSE personnel at least in 1987-1988 did not use applied methods of mathematical modeling for the optimization of VX related technological processes. Instead the MSE technical personnel tried to apply laboratory results directly to an industrial-scale processes. This reflected their lack of understanding of problems inherent in the large-scale production of VX that resulted in problems associated with the optimization of production parameters (such as temperature, concentrations and quantities of the raw materials).

[7] Details of the VX programme are described in Chapter III.

All of the technological modification Iraq made in order to improve VX production were intended for batch processes. The level of the development of analytical control techniques available at the MSE at that time is difficult to determine due to the lack of technical data. Gas chromatography techniques were applied for the analysis of nerve agents and their precursors. These techniques required high purity standards that were lacking. In addition, Iraqi personnel lacked familiarization with the specific procedures suitable for the analysis of polar and temperature sensitive compounds. However, MSE staff applied other quantitative and qualitative methods of analysis such as wet chemistry, IR, NMR and UV.

Given the absence of information on VX activities at MSE during the period 1989-1990 it is not possible to evaluate, with confidence, whether or not Iraqi mastered VX production technology on an industrial scale.

Lesson: "Dibis" a remedy for unstable VX

As Iraq demonstrated, production processes for VX can be country specific. Iraq used an "unconventional" solution to compensate for its failure to obtain stable VX.

CW agent weaponization

Iraq's CW agent weaponization mainly relied on the adaptation of conventional munitions for the dispersion of CW agents. In most cases, these adaptations were performed by or coordinated within Iraq's military industrial establishments. The critical components, needed for these munitions to be suitable for CW applications, included optimized burster charges of specific size and shape and other minor components, such as sealing rings, filling ports and agent containers. All these parts were supplied to SEPP/MSE by various establishments.

Lesson: Conventional munitions for the delivery of CW agents
Iraq's CW agent weaponization mainly relied on the adaptation of conventional munitions for the dispersion of CW agents, e.g. smoke munitions.

Understanding all conventional delivery means available to Iraq is another area that was essential for international inspectors as it impacted the selection of CW munitions by Iraq. Since delivery systems formed the cornerstone of Iraq's conventional and chemical weaponization programmes, it is critical for international inspectors to understand their capabilities to assess past, present or future chemical weaponization scenarios.

Programmes and Processes

According to information received through interviews and declarations, the P-7 plant was equipped to produce tabun (and then sarin). It was later converted to the production of MPC that is one of the most critical chemicals needed in the production of sarin, soman and VX. Since MPC was an absolute necessity and a critical element in the nerve agent programme and could not be imported, indigenous production became a very high regime priority.

Lesson: MPC a good indicator of nerve agents
The production of chemical precursors is as important as the production of agent itself. The production of MPC in particular and its precursors can be a very good indicator of the scale of a nerve agent programme.

Nerve agent requires no major purification for effectiveness if it is to be used within weeks of production. During the Iran/Iraq war, Iraq produced several hundred tonnes of nerve agents, mainly tabun and sarin. During this wartime phase, no appreciable or complicated purification was performed for any of these agents. Relatively low purity agents were accepted by Iraq for warfare. These crude products began to degrade the moment that they were synthesized. Therefore, timing was important in using such materials for warfare.

Lesson
Under extreme time constraints with urgent and immediate demands, complex production projects may be simplified for reasons that at first seem difficult to understand.

Production facilities vis-à-vis R&D facilities

Depending on the reason for production and the concept of use, different facilities with various capabilities and capacities ranging from R&D, pilot-scale, to large-scale processes could be used for producing CW agents.

Small-scale study

The production of militarily significant quantities of CW agents using pilot-scale equipment could take place in various types of chemical facilities (for example, research and development laboratories, test facilities, industrial plants). Such units also might be assembled and operated in some other facilities and not necessarily at a chemical site.

Quantities of CW agents and precursors were produced using a battery of equal or similar units of pilot-scale chemical equipment. This requires the use of more equipment of that type thus its accessibility and servicing capabilities become of key importance. Iraq's difficulties in both areas significantly reduced its capabilities over time.

In future, the existence of a battery of units consisting of scale-up chemical equipment in identical or very similar configuration suitable for CW agents and their precursors might indicate activities going beyond conventional research or scaling-up and should be subject to thorough inspection. Even storage of such units in a disassembled state should raise interest since the time necessary for assembling or the reconfiguration of pilot-scale plants is much shorter than for industrial scale plants.

Lesson
Industrial scale equipment is not necessary in order to produce industrial scale volumes. This can be done at a price by using batteries of pilot-scale equipment. Iraq proved the possibility of using non-industrial scale equipment for the production of militarily significant quantities of CW agents despite the fact that such equipment is generally not specifically designed for such purposes.

Elements of a WMD programme

In the past, Iraq employed a concealment policy which involved hiding more advanced results (Al Hussein warhead), understating the scale of production (VX programme) or agents filled in munitions (Al Hussein missile warheads), or removing from a site, equipment involved in chemical warfare agent programme. Thus, it is possible that the CW programme was more extensive or complicated than declared.

Lesson
The issue of what is relevant to the verification of a CW programme goes beyond the scope of just CW agent production and weaponization since it comprises components and manufacturing capabilities applicable for both, conventional and chemical munitions.

LESSON LEARNED - MISSILE PROGRAMME

The Resolution

Security Council resolution 687 (1991) prohibits Iraq from having a ballistic missile capable of exceeding a range of 150 km. This decision primarily reflects concerns to protect major cities in Israel and Iran from Iraqi missile attacks and in essence represents half the range of the SCUD B imported from the Soviet Union. However, from an inspection and enforcement perspective, there is no technical dimension behind the range limit. Whether the limit refers to no payload, some payload, flying to fuel exhaustion (thus no effective control), and optimum trajectory, atmospheric conditions and whether it refers to a deployed missile, a missile test or a theoretical drawing was never spelt out and left to experts to interpret. As a result, the applicability of the 150 km range limit was subject to debate between the UN and Iraq. The monitoring plan expanded the term "ballistic missile" to include cruise missiles and unmanned aerial vehicles and remotely piloted vehicles.

Not only did difficulties arise from the way in which the missile part of resolution 687 (1991) was interpreted but according to this resolution, Iraq was still permitted to develop, build and test missiles to a range which did not exceed 150 km. Deciding what missile systems could and could not exceed the range was not always a straightforward matter and similarly for decisions on the technologies supporting such missile systems.

Lesson: Know what you want
The nature of the resolution that specified restrictions to missile range alone gave rise to ambiguities and debate. While it is more difficult to be comprehensive and the post-Gulf War resolutions were put together quickly, specifying missile range alone without any other technical requirements was insufficient as a sole criterion for the basis of inspection.

Missile inspection teams

Team composition
Missile inspection teams require specific expertise and perhaps more so than for either the chemical or biological areas. While it was necessary to have a range of general expertise within the team, such as those qualified as electrical or mechanical engineers or those with experience in propulsion systems, it was essential to have experts who had experience in the exact systems subject to inspection. For example, when inspecting an SA-2 missile it was essential to have experts who had worked on SA-2 missiles and not just inspectors who had some familiarity with other missile systems or missiles in general.

As each missile system has peculiarities and they are essentially national systems there are different ways of approaching problems associated with maintenance or operations that may not be obvious. Mistakes in assessments and poor judgments were made at times with a particular missile because the inspectors involved did not fully understand

the system with which they were dealing. There was often a discrepancy in knowledge or a divergence in views between inspectors and host country experts. The host country experts had the advantage of actually working on the specific missiles under inspection whereas many UN inspectors had not. Also the difference of opinion between UN inspectors meant that fluctuations in assessments occurred ranging from Iraq's missile capabilities being extremely limited and basic to Iraqi missile personnel being extremely clever and Iraqi capabilities being greater than met the eye.

In a practical sense, given the limited number of inspectors that usually comprise a team, it will not be possible to assemble every team to include inspectors with expertise in every area of every missile system. For example it may not be possible to include experts in liquid propellant production. However, from a UN perspective, it seems that developing and using a roster of experts with a wide range of specific skills was a more reliable way of being able to form a team with appropriate experts rather than relying on a supporting government to supply such people.

Team building and continuity of knowledge are crucial for any successful inspection. Continuity can occur either through written reports and data analysis or by having some of the same inspectors on successive missions. The benefit of continuity is that first hand knowledge is retained and therefore it is easier to progress some issues without the need to learn or relearn facts already gathered. The disadvantage to continuity is that personal views can get entrenched and these are not changed easily despite additional and sometimes contradictory information being available. Those with continuity in inspections are more likely to be of senior rank and therefore in a position to ignore or overrule views of others. Depending on the inspector's knowledge and personality, bad judgments can get set in concrete. The lesson from this is the need to have an experienced pool of experts who become familiar with particular missile systems and who review and challenge each other's assessments and judgments.

Although not confined to the missile inspections, some missions had insufficiently defined mission objectives and poorly defined roles for individual inspectors. This created uncertainty once at a site with some inspectors not knowing what was expected of them, or what was to be achieved. The choice of chief inspector was crucial to managing the inspection, taking responsibility for team performance and for giving clear instructions to individual team members. The choice of the operations officer was also vital in making sure that the team logistics were well organized and that the team actually arrived at the correct site. In both cases, academic or scientific qualifications alone were no criteria for selecting either the chief inspector or operations officer: experience and appropriate background in these fields was a much better criterion.

Missile Destruction

UN inspectors had a mandate to destroy, remove or render harmless Iraq's WMD and supporting infrastructure. During early inspections in particular, UN inspectors were too focused on destroying the prohibited missiles, launchers and associated equipment rather than on collecting and preserving the evidence until all necessary information from it had

been secured. Some of the sense of urgency in destruction was due to either perceived or real political pressure and was sometimes incorporated into a mission statement.

Destruction in some instances, took place without recording serial numbers on engines or taking photographic evidence, recording markings on the airframe or studying design details. The need for this information at a later date meant the re-excavation of burial sites to revalidate specific missile information. In hindsight, UN inspectors could, for example, have rendered harmless SCUD missiles by crushing a part of the airframe or drilling holes in the engine, and then sealing these missiles in a warehouse until eventual destruction after it became clear that all available data was extracted and the missiles were no longer required. The Executive Chairman should decide when to destroy evidence but there should be consistent policy guidelines, directives or instructions for inspectors in the field covering what to destroy and the method of destruction and the necessary recording of data. This is especially so for a new organisation to ensure consistency rather than leaving the decisions to be made on an ad hoc basis by individual chief inspectors. In later inspections involving the Al Samoud-2, UN inspectors systematically recorded all details during UN supervised destruction.

Photographic and documentary evidence
As evidence for later review, video imagery proved more useful generally than still photography. Generally, video evidence at missile sites captured much additional data, particularly of the overall site itself and this produced other valuable reference data. Still photography proved useful when recording specific data such as engine numbers and individual items.

Access to appropriate documentation is crucial. Without such documentation, the chances of UN inspectors obtaining the required data for verification are slight; this is not a good situation for either the inspected country or the UN inspectors. Documentation has proven more reliable than interview evidence when memory and different perspectives can colour what has been said.

For missile inspections in particular, export/import documentation proved one of the best sources of credible data. Access to such data relied on the good will of the governments involved; some were very good, others fair and some were uncooperative. Good relations between UN inspectors and exporters also meant that not only was contractual information available, but also information regarding what was asked for and not just what was supplied. Such data opened up new lines of investigation and provided a timeline of activities and reflected intent.

Lesson: Missile inspections worked
One of the primary lessons learned with regard to the missile inspections in Iraq is that the UN was able to establish quickly an inspection regime for disarmament and, later, monitoring missions that were effective and worked. This was the first such international regime ever to be established.

Lesson: Need specific hands-on experience

The team should include inspectors with hands-on experience in the specific missile systems being inspected. Having familiarity with other missile systems or missiles in general is not always sufficient to make well-founded judgments and assessments.

Lesson: Roster the better option
While it is not always possible to cover every area of expertise that may be needed, it is more likely that there will be available inspectors with the required expertise by having a well-developed roster rather than by relying on supporting governments to make such people available.

Lesson: Balanced continuity needed
Having some personnel with continuity in inspection missions is highly beneficial to move an inspection process forward; however the pool of such people should be large enough to prevent one particular view from becoming entrenched in the face of inconclusive evidence. There is no formula for the correct balance of experience and continuity versus the fresh eyes of new inspectors but a mix is desirable.

Lesson: Chief Inspector and Operations Officer – choose wisely
Mission objectives must be specific so that an inspection team knows exactly what is expected of it. The chief inspector and operations officer are crucial for a successful mission and should be chosen on personal qualifications and experience and not simply on academic or scientific prowess.

Lesson: Destroy in haste, regret at leisure
There should be consistent instructions provided to inspectors that cover all aspects of destruction in the field. Hasty destruction of some missiles led to a two year re-excavation programme to recover and check data supplied by Iraq. This could have been avoided if the missile systems were rendered harmless and stored in a sealed facility until all necessary data was recorded and the Executive Chairman then authorized destruction.

Lesson: Take the video
As evidence for later review, video imagery proved more useful generally than still photography.

Lesson: No documents, no data
Without documentation, the chances of UN inspectors obtaining the required data for verification were remote. For missile related inspections, import and export documentation in particular proved an extremely valuable source of information.

Technology know-how and qualified personnel

Iraq used its knowledge of its imported liquid propellant missiles as a basis for the development, production and testing of their indigenous liquid propellant missiles. Iraq was able to manufacture airframes and some of the simpler missile components but because of inadequate expertise and poor quality control during production, they never

mastered manufacturing entire missile engines that consistently worked. For example, Iraq never manufactured a SCUD engine that was reliable despite many attempts; the Al Samoud-2 used SA-2 engines as Iraqi attempts to manufacture engines of this size also failed entirely or failed to be of consistent quality.

In addition, for precision parts Iraq had to resort either to scavenging from other missiles or importing these parts. However, despite this limitation, the construction of the Al Samoud-2 is proof that Iraqis were able to make good use of the liquid missile components available.

Lesson: Money alone won't buy it

UN inspectors observed that Iraqi engineers and scientists had a good understanding and knowledge of the liquid propellant engine technology used in the SCUD and SA-2 missiles but these engineers were unable to translate this knowledge into practice and the manufacturing part of the missile programme was still their weakest point. Despite years of having operational missiles and technical assistance as part of an imported package (such as the SCUDs), Iraqi industry still lacked the ability to precision manufacture critical missile parts. Iraq was forced either to cannibalize older missiles or try to import the necessary components that it failed to produce. Iraq never managed to master the indigenous manufacture of a reliable SA-2 or SCUD-sized liquid propellant engine in its entirety.

Despite the implementation of MTCR and other national missile-related export controls, during the period from 1987 to 1990, Iraq managed to procure some parts and technology for gyroscope production. However, Iraq did not manage the production of complete gyroscopes because of shortfalls in the abilities of its workforce, in particular, the lack of Iraqi technical abilities, practical experience and skilled manpower. With time (at least five years), it is possible that these problems could have been overcome. The destruction of the infrastructure during the 1991 Gulf War and the export/import mechanism established later effectively delayed further any Iraqi attempts at indigenously producing gyroscopes and accelerometers. The knowledge and the experience acquired during the 1980s and 1990s did provide Iraq with a limited ability to develop by the mid-late 1990s an inertial navigation system based on gyroscopes and accelerometers scavenged from surface-to-air or air-to-air missiles.

Lesson: No skill, no production
It was the lack of technical abilities, practical experience and skilled manpower that prevented Iraq from producing gyroscopes. Prior to 1991, Iraq had imported equipment and machinery for the production of guidance system parts but never mastered the manufacture of consistently high-quality components.

Even after 15 years of effort with its substantial financial resources, Iraq did not manage to develop and manufacture gyroscopes and accelerometers.

Iraq tried to compensate for this lack of expertise by seeking foreign assistance but it was not a great success. Despite the large amount of money spent on contracts with non-state companies or individuals, Iraq only managed to integrate a guidance and control system for the Al Samoud missile from existing equipment (SA-2 technology - 50 years old) but did not produce an indigenous guidance and control system. For Iraq to achieve its goal, extensive foreign support would have been necessary.

Lesson: Foreign assistance necessary but not sufficient
Manufacturing inertial navigation sensors or making the integration of existing sensors for guidance and control systems met with only very limited success despite some foreign assistance. Iraq lacked the necessary skills and competencies to utilise foreign assistance in developing a modern guidance and control system for Iraqi missiles. This remained the case despite years of effort and many resources.

Development and use of missiles and missile components

Although there was a great deal of media coverage on the use of SCUDs by Iraq during the "War of the Cities" between 1985 and 1988 and the Gulf War in 1991, the missiles used were largely the Iraqis' own improved SCUDs, the Al Hussein. The improvement made by Iraq consisted of increasing the quantity of propellants while decreasing the mass of the payload in order to achieve a longer range. It was possible for the Iraqis to proceed on this improvement because the 8K14 (imported Soviet SCUD) was a very simple and robust missile. The configuration of the 8K14 did not differ much from the V-2 missile produced by Germany in 1940. Iraq had a considerable quantity of 8K14 missiles and they took the risk of cannibalizing several of them. Under the pressure of war, Iraq's goal was to develop a reliable strategic missile system capable of reaching Tehran. With a circular error probable (CEP) of around 20 kilometres at maximum range, the Al Hussein was effective only against large population centres. A missile that delivers a 200 kg high explosive warhead with a low accuracy may be used as a deterrent weapon, since the comparison between weapon cost and physical damage produced (as distinct from psychological damage) is very poor. Even though Iraq attempted to produce their own SCUD missiles by reverse engineering and, to this end, was able to import some critical components, such as turbo pumps, they still were far away from mastering the indigenous production of SCUD type missiles.

UNMOVIC specialists together with specialists from countries that still operated SA-2 systems considered several ways of modifying SA-2 surface-to-air missile into a surface-to-surface ballistic missile. The methods UNMOVIC devised were compared with Iraqi declarations. The option selected by Iraq in 1988 seems to have been one of the easiest ways to modify the 20DSU, the oldest SA-2 variant purchased by Iraq. Although there are solutions to modifying the missile that would achieve a greater accuracy, the method chosen by Iraqi specialists was the simplest and not accurate. Although modified SA-2 missiles were of relatively low value as military weapons, Iraq would have had little difficulty in converting additional SA-2 missiles into Fahad 300s if it had so desired.

Lesson: Don't over estimate capabilities

There was nothing sophisticated or technically complicated in the Iraqi approach to modifying its imported SCUD missiles. Because of the ambitious intentions and the huge amount of money spent for reverse engineering of SCUD missile, there was a natural tendency by UN inspectors and others to overestimate Iraq's progress and the results obtained.

The option selected by Iraq to modify the SA-2 missile seems to have been one of the easiest, albeit less useful, ways to modify the 20DSU, the oldest SA-2 variant purchased by Iraq. This again reflects not just the pressures of war but also their limited capability at missile modification.

As a declared 80 km range surface-to-air missile system the Al Ubour was not covered by the prohibition imposed on Iraq by Security Council resolution 687 (1991), but the Al Ubour could have been used for a much longer-range surface-to-surface missile. In addition, the Al Ubour propulsion system observed by UN inspectors during a 12 January 2003 static test was very heavy. This propulsion system, particularly the motor case/nozzle assembly, could have been made much lighter enabling the missile to possibly exceed the 150 km limit if configured as a surface-to-surface missile. The Al Ubour missile's final design was still under development.

Lesson: Look for possibilities

Although not prohibited, the Al Ubour propulsion system could have been used as a booster for a longer-range surface-to-surface missile or the missile could have been lightened to exceed the range limit in a surface-to-surface configuration.

Range of missiles

The range of a missile that is fully developed with a known fixed payload can be determined on the basis of flight tests or technical documentation. The determination as to whether the missile is prohibited is easy if the missile clearly exceeds the allowable range by a large margin, as in the case of SCUD-B and Al Hussein missiles (which have maximum ranges of about 300 and 600 kilometres respectively). But if a missile's range is somewhere in the vicinity of the permitted value, then expert evaluation and judgment are required since the results of flight tests may depend on particular environmental conditions. Such was the case when UNMOVIC determined the Al Samoud-2 missile, which was developed during the period from 1999 to 2002 in the absence of international inspectors, to be a proscribed missile. That determination was made on the basis of the assessment of an international panel of experts that considered both the available flight test results and the missile's design and judged the missile to be inherently capable of exceeding the permitted range (see S/2003/580).

It is well understood that the range of a missile is affected by different design configurations, including the weight of the payload. Thus, it is more complicated to

establish the possible maximum range of a missile system under development or at the modification stage, since the results of flight tests would depend on multiple parameters, such as fuel load, payload and engine shut-off (burn time), that could be changed at a later stage and could thus affect the range value. Furthermore, if the design of the missile has not been finalized, it is difficult to know what values for different parameters should be used for an assessment based on design.

Lesson: Need more than flight tests to judge range
Flight tests alone are insufficient criteria to make a judgment on a missile under development. A panel of international experts was convened to help UNMOVIC decide on whether the Al Samoud-2 was a prohibited missile or not because, given the missile's characteristics, it was not obvious. It was even more uncertain with the Al Fatah missile. Despite a meeting of international experts and access to computer simulation models because of insufficient detailed information available at the time, no conclusion was drawn as to whether or not the Al Fatah was proscribed. Accurate information on design parameter values and on configurations tested has to be collected and verified in order to assess the range capability of missiles.

The ISG learned from Iraq in 2003 that a project called Jenin involving the HY-2 cruise missile was under development. The project had as a goal the replacement of the liquid propellant engine of the HY-2 with a turbojet engine (converting the MI-8 helicopter turbo-shaft engine into a turbojet engine). The concept of equipping the HY-2 with a turbojet engine was not new. According to open source documents, China developed the HY-4 (a later version of HY-2) in late 1980 using an indigenously produced turbojet engine. According to some other documents North Korea developed a cruise missile using the same conceptual design. What is new is the idea of modifying the helicopter turbo-shaft engine into a turbojet engine. It would seem easier, from an engineering viewpoint, to design and produce a new turbojet engine rather than to modify a turbo-shaft engine but many times Iraqi specialists were doing unusual things with mixed but usually poor results.

Lesson: Don't ignore the unusual
A lesson from the missile HY-2 project is that it does not matter if the project looks unusual; all the information must be exploited and the goals fully understood.

Modifications

Provided that there is a pool of missiles in the inventory that can be used, Iraq demonstrated that they could modify a liquid propellant missile to extend its range. Iraq showed that this was true for all of its liquid propellant missiles: some of its surface-to-surface, surface-to-air and anti-ship cruise missiles were modified to extend the range and in the case of the Styx-type and SA-2 missiles, change the function and flight profiles as well. Iraq made some attempts to modify solid propellant missiles to increase range but they were mostly unsuccessful. It is much more difficult to modify solid propellant missiles because, once cast, the solid propellant motor is fixed and cannot be easily

disassembled or changed to increase substantially the range of the missile. Iraq initially purchased SCUD missiles for deployment not for modification and it was only in the mid-1980s when attempts to procure a longer range missile failed that Iraq tried to extend the range of this missile system.

Although the basic technical knowledge relating to generic missile design and performance was available in the open literature, in order to successfully modify a liquid propellant missile, a thorough understanding of the operational requirements for each individual missile system is required. For example, to extend the range, the requirements for modification of a SCUD are different from the modifications of an SA-2. In order to modify the SA-2, it had to be converted to a surface-to-surface missile that in turn involved disabling the self-destruct mechanism and modifying the operation of the guidance and control system. Pre-1980s SA-2 missiles were supplied with technical manuals for maintenance. Technical manuals included detailed data relating to electronic circuitry, wiring diagrams, kinematics and operational features and parameters of major components and sub-components. These manuals proved very useful when Iraq undertook modification of this missile system. The use of detailed technical manuals was less important for the extended range modification of SCUD missiles.

Besides having the available manuals, another useful factor in Iraq's successful modification of its liquid propellant missiles was extensive training of its personnel in the operational mode of these missiles. This was often supplied as part of a package deal with the importation of the missile system.

Lesson: Modification – Liquids are easier than solids

Since Iraq had imported a number of liquid propellant missile systems and had acquired considerable detailed operational understanding of these missile systems through training packages and technical manuals, it was relatively easy for them to embark on a programme of modification to extend the range of these missiles. Modifications can be done on liquid propellant missiles using basic industrial infrastructure. It is not necessary to have complex machinery or equipment. Many of the modifications necessary to extend the range of the SCUDs were done in mechanical workshops without modern, state-of-the-art equipment.

Modifications of liquid propellant missiles went beyond extending their range and included altering the flight profiles of missiles such as the SA-2 (surface-to-air missile) and the HY-2 and P-15 (Styx-type cruise missile). The SA-2 has an inherent surface-to-surface capability and it was a much easier option for Iraq to modify this missile than try and develop an indigenous system.

Comment
Since the configuration of liquid propellant missiles can be changed through relatively simple modifications that allow range to be extended, there are obvious implications for countries that supply such missiles. Supplying countries (besides limiting technical information through manuals and training) could also consider building in un-modifiable

or limiting features to their missiles if they are concerned about a receiving country altering specifications. For example, technical impediments such as limiting burn time, and valves or seals that cease to operate after a certain time from launch could be considered).

Although many countries have concentrated on the production of solid propellant missiles since the 1990s, the supply of liquid propellant missiles will still be a concern in the future.

Indigenous production

Indigenous production is much more difficult than modification of missiles.

Indigenous production of missiles or their key components requires a dedicated industrial infrastructure; it is not possible to use basic industries because of the specialized requirements. For example, in order to manufacture some of the major components for liquid or solid propellant missiles, facilities must have vibration free areas, temperature stability, and clean room conditions and be able to do machining to within tolerances of microns. Unless these very strict specifications are met, it is not possible to achieve totally indigenous production.

Lesson
Because indigenous production requires specialized infrastructure, for a country like Iraq, much of this infrastructure would have to be imported. Imports of such infrastructure are difficult to hide and therefore indicators of such activity will be visible.

Reverse engineering is easier than indigenous design.

Only a few countries have a proven capability to indigenously design a complete missile system. Many of the "new" missiles developed by other countries are copies, at least in part, of existing systems. Reverse engineering pre-supposes that some missile system has already been acquired. Reverse engineering is copying from an existing product – instead of working up from the drawing board to development and manufacture, reverse engineering starts with an existing proven product and disassembles it, finding out the design, capabilities, specifications and workings of each part, so working in reverse.

Iraq has never attempted to produce an indigenously designed missile and always followed the route of reverse engineering a proven imported missile system.

Lesson
The quickest way to produce a missile is through a reverse engineering process. This process, however, could place an inherent limit on the capability of the missile system as technology and operational limits are restricted to the design of the original missile system.

Well-developed relevant support industries are a pre-requisite for reverse engineering.

If a country does not have support industries such as electronics, mechanical and electrical engineering facilities, chemical facilities and welding and construction capabilities, it will not be able to do reverse engineering of missile systems. An experienced and competent pool of technicians is needed for major component manufacture such as engines, and guidance, navigation and control systems.

Lesson: Look beyond the missile project
In making an assessment regarding a country's ability to reverse engineer a missile system, inspectors need to take into account the support industries and so look far beyond the project itself.

Comment
Supplying countries could place license agreement provisions against any modification or copying of a missile system supplied. Failure to comply could mean ceasing supply of support and assistance, training or maintenance and the canceling of future sales.

Production Equipment

In order to produce a missile, a country requires a great variety of production equipment such as lathes, moulds and dyes, metal bending and welding equipment, presses and other sometimes specialized equipment, as well as the basic material supplies such as metal sheets, and other raw materials. Iraq could not make any major item of production equipment or any machine tools; all had to be imported as well as many of the raw materials requirements.

Lesson: Production equipment is as important as material supplies
For an accurate assessment of indigenous reverse engineering capability, both production equipment and material supplies have to be taken into consideration.

Importance of Mid-Level Technicians

Iraq had a number of high-level well-qualified technical experts and these were the main decision makers behind the missile system development and deployments. However the bottleneck for Iraq was a shortage of a number of skilled technicians at the mid-level (such as experienced and well qualified welders, metal workers and lathe workers). Over-qualified staff started the production of some missile systems but Iraq lacked a body of people to work the appropriate machines and equipment. As a result, there was extremely poor quality control in many of the missile projects.

Lesson: Look down
Inspectors need to look well below the top level of managers in the missile projects in order to assess accurately Iraq's capability at indigenous production.

Warhead Design

Iraq found that missile warheads were relatively easy to produce compared with other parts of the missile and that it was also relatively easy to adapt a warhead for a CBW payload. Iraq developed and modified a canister (made of either aluminium or stainless steel) for a chemical or biological agent fill. The design may not have been an efficient delivery mechanism or even effective but it fitted the missile and could hold the agent. Iraq also never saw a problem with fitting a nuclear warhead onto the SCUD/Al Hussein missiles. Again, perhaps it would not have been effective or may not have even worked but as far as a system designed to carry a nuclear weapon was concerned, Iraq was satisfied it could achieve its objective. The IAEC (Iraqi Atomic Energy Commission) initially had a programme to design a weapon system capable of being fitted into a 1.25 metre diameter warhead canister. Later, when a crash programme was implemented, General Ra'ad had proposed a design to accommodate a nuclear warhead on his 0.88 metre diameter Al Hussein missile.

A major area of weakness for Iraq was in its attempts to produce fuzing and arming devices. Despite understanding the many pressing and urgent problems which required such indigenous production, Iraq had difficulty in mastering the necessary technology to produce its own fuses, other than impact fuses, for its warheads. Iraq only used impact fuses in its deployed missiles but was undertaking development of timing and barometric fuses.

Iraq did not succeed in producing a warhead suitable for cluster munitions or bomblets. Attempts were made with both FROG-7 and SCUD missile warheads with no success – only the Ababil-50 had sub-munitions that worked.

Excess temperature damaging the warhead contents does not seem to have been a problem for Iraq. Conventional explosives such as TNT melt at about 80ºC but this temperature was never realized during flight of the Al Hussein missile. However, Iraq put some insulation over the inside of the warhead shell assuming this would have been needed because of the extended range and consequent temperature increase in the Al Hussein. It is unknown whether Iraq conducted any dynamic or static ground tests for heat effects on warheads.

Iraq declared that initially it had a problem with the mating or alignment of imported rings that linked the missile body with warheads made indigenously. Although Iraq successfully accomplished more difficult and complicated feats of engineering, they still claimed that initially there were problems. As a result, Iraq matched specific missile bodies with specific warheads, i.e. warheads were not interchangeable among missiles.

In a conventional SCUD warhead there are three detonators. This concept was still used when the warhead was modified by Iraq for a CBW payload and hence the three burster tubes that Iraq had in its CBW warhead canisters. Despite the different degrees of

strength, softness and weight between the aluminium and stainless steel warhead canisters, there was no difference in the burster tube sizes, detonators or fuzing mechanisms.

Lesson: Unconventional warheads are difficult to produce
A main lesson learned from warhead design relates to Iraq's perception that it was relatively easy to produce a missile warhead. In fact, despite their perception that warhead design was a relatively easy procedure, some of the targets set for completion of products (such as that with the IAEC) were unrealistic. This in turn implied that Iraq had little understanding of the complexities involved. There is no evidence that Iraq mastered the technology of producing a warhead that would be efficient in delivering a chemical or biological agent.

Airframe

Since Iraq was looking to increase distance of its long-range missiles. Modification to stretch the airframe was not a great problem. Airframe welding and assembly was crude but good enough to work. Initially Iraq had to cannibalize the airframe of SCUD missiles for use in the longer-range Al Hussein missile but eventually it was successful in manufacturing its own airframe from metal sheets. Materials used for the Al Hussein airframe production were below the quality of that controlled by the MTCR.

A main problem in airframe manufacture was related to separation technology. Separation is required either to increase the range of the missile through staging or to increase the accuracy of the payload by reducing the drag on the reentry vehicle. Iraq had problems with developing separation technology – regardless of whether this applied to the warhead or stage separation of the missile. Iraq was not able to fully implement separation technology up to the deployment stage. Iraq tried both linear charges to cut the circumference of the missile to achieve separation (this did not work) and explosive bolts with springs (this worked but was not operational before the outbreak of the Gulf War in 1991).

Iraq tended not to devote enough attention to systematic testing of missile components but rather rushed to missile flight test. In addition, Iraq rarely used standard scientific methods to collect and evaluate test data and subsequently to incorporate corrections into design and production methods.

Lesson
Although Iraq made progress in manufacturing some missile airframes, it still needed to import stiffening rings. All manufacturing equipment and raw materials were also imported. Such imports could be a good indicator of missile-related production activity.

Staging and separation technology are difficult to achieve so attention needs to be paid to imports of associated technology.

Liquid Propellants

Iraq did not succeed in manufacturing liquid propellants such as IRFNA, TM185 and UDMH. Until 2002, Iraq claimed that it could not make concentrated nitric acid (a basic component for the SCUD oxidizer, IRFNA) and could only refurbish life-expired imported IRFNA through filtration. Although Iraq had a refining and petrochemical industry it did not produce TM185 (a kerosene type fuel) and had plans to import a turnkey facility.

Iraq showed considerable interest in using UDMH as a missile propellant. It had imported some quantities of UDMH and had orders for even larger quantities. After the return of UN inspectors in 2002, Iraq declared that they had succeeded in implementing pilot-scale production of UDMH. Iraq found through results of static testing, that it could not use UDMH as a substitute for the original propellant in SCUD engines.

Lesson
The verification and monitoring of propellant production will have to extend beyond the missile industry to include petrochemical facilities, refineries and organic and inorganic chemical industries.

Engine technology

This is the most complex part of the missile. Iraq could not design its own liquid propellant engines and even when they tried to apply or reverse engineer foreign designs, they failed. Iraq tried to copy SCUD engines from missiles imported from the Soviet Union. Despite having high quality machine tools and workshops, Iraq failed to manufacture liquid propellant engines. For example, they had good quality flow forming machines but produced poor quality combustion chambers and they failed to assemble or make turbo pumps despite many attempts**.** Even for Al Samoud-2, Iraq had to use imported SA-2 engines. Iraq did not succeed because they lacked knowledge and had little expertise in missile engine production technology, had little production quality control and poor discipline in production.

Lesson
Liquid propellant missile engine design and production is the most difficult technology to acquire and master and this is a critical point for inspection and monitoring.

Guidance and Control

Imported Soviet produced SCUDs incorporated 1950s guidance and control technology based on electro-mechanical components. For some components of the guidance and

control system, Iraq tried but failed to copy the SCUD system, in particular the gyroscopes. Eventually, Iraq had to import all components.

Iraq's earlier attempts to design its own guidance and control system also encountered difficulties because of the complexities of these systems that Iraq attempted to copy. Later, for the Al Samoud guidance system, Iraq was partially successful because it was able to integrate scavenged imported gyroscopes with other indigenously produced electronic subsystems.

Lesson
This is a critical activity to monitor. Because of technological developments in the computer and electronics industries, it is easier now to achieve indigenous production of guidance and control systems rather than try to copy foreign systems from imported missiles with outdated technologies. Nevertheless, monitoring the activities of guidance and control design and production would remain a key requirement for inspections, including the importation of gyroscopes and accelerometers.

Launchers

Despite some problems with hydraulics and alignments, Iraq had no great difficulties in making launching systems, either fixed or mobile. They bought commercially available trucks and flatbed trailers and made the necessary modifications so these systems worked as mobile launchers.

Lesson
Launchers, whether fixed or mobile, are relatively easy to modify or produce. Monitoring should therefore focus on more difficult elements of a missile programme.

Cruise Missiles

Prior to 1991, Iraq did not have long-range cruise missiles and cruise missiles were not included initially in the Security Council resolutions of 1991. Later the Security Council decided to extend the coverage to include cruise missiles as they could perform essentially the same function as surface-to-surface ballistic missiles. Iraq's cruise missiles were subject to monitoring by UN inspectors.

Iraq had showed interest in extending the range of their cruise missiles. They followed the same approach to extending the range of Styx-class missiles as with ballistic missiles, that is, reducing payload weight and increasing fuel capacity. After the withdrawal of UN inspectors in 1998, Iraq nearly doubled the range of these cruise missiles and reportedly used some of these modified missiles against land-based targets in the 2003 Gulf War.

The most difficult part of this modification was to alter the original guidance and control system of the existing missile.

Lesson
Cruise missiles have the same inherent capabilities for range extension as liquid propellant ballistic missiles. To achieve the objective of significant increase of range, extending the airframe of a cruise missile is not feasible and the modification path will be different: modified cruise missiles will have to use more efficient engines, for example gas turbines. Special attention should also be paid to modification of cruise missiles for CBW agent delivery.

UAVs

Iraq's interest in UAVs increased after 1998. This coincided with the developments in the relevant technologies globally and the increased military and civilian use of UAVs in many countries and the commercial availability of components such as inertial navigation systems.

By 2003, Iraq managed to develop a UAV with a take-off weight exceeding 50 kg and a range exceeding 100 km using an airframe developed domestically (although based on foreign design concepts), imported engines and guidance and control systems assembled from imported components such as simple GPS systems, inertial navigation units and gyroscopes.

Iraq also tried earlier to modify aircraft such as the MiG-21 and L-29 to operate as UAVs. These programmes met with limited success.

Lesson
UAVs will be difficult to monitor because of the ease of modifications that relate to payload and range. It would seem that take-off weight and guidance and control systems are the most important UAV features and monitoring operations should focus on these features rather than following patterns suitable for ballistic missiles.

Supergun

The Supergun could not have been attempted by Iraq if not for significant foreign assistance with regard to both expertise and the major components. All major components had to be imported as relatively few foundries in the world could have produced pipes of the size needed for Iraq's Supergun. This was a very exotic project with very little military significance. This project appears to have been a trade-off for outside expertise on the Al Abid space launch system.

Lesson
Given its unusual nature, a project similar to the Supergun is unlikely to be repeated.

Al Abid

In its only test flight on 5 December 1989, the Al Abid space launch vehicle flew for about 45 seconds before encountering a problem. This space launch system consisting of

a cluster of five SCUD engines for its first stage had the potential to deliver a payload, including nuclear, to an intercontinental range.

Lesson
A country can achieve a space launch capability by modifying short-range (for example SCUD-sized) ballistic missiles by using clustering and staging technologies.

Work on a space launch system could conceal activities especially in the areas of missile clustering, staging and separation. It appeared that Iraq was using the Al Abid space launch programme for developing longer-range, multi-stage ballistic missiles. A space launch programme could be a convenient way of developing, testing and even launching longer range missile delivery systems.

LESSONS LEARNED – BIOLOGICAL PROGRAMME

The lessons learned by the UN weapons inspectors from the verification process of Iraq's BW programme are somewhat different than for the chemical and missile programmes. The latter two were known to some degree before international inspectors entered Iraq, whereas the BW programme was almost entirely concealed. Thus, the immediate priorities for the UN inspectors were destruction and rendering harmless of known stockpiles of chemical agents, chemical weapons, missiles and associated facilities and an investigation of Iraq's nuclear programme, which perhaps concerned members of the UN more so than any other programme. Because the full extent of the BW programme was unknown in the early 1990s, it received less priority.

The biological weapons programme of Iraq was much smaller than its chemical weapons programme and various missile projects in its size and scale. The programme, which was the last started among Iraq's efforts in the field of weapons of mass destruction, materialized after Iraq had already developed and deployed its chemical weapons and progressed in the modification of foreign missile systems.

Security Council Resolution

UN inspectors were mandated to destroy, remove or render harmless all of Iraq's WMD programmes and long-range missiles. Although resolution 687 (1991) referred to previous international weapons conventions and agreements such as the 1925 Geneva Protocol and the 1972 Biological and Toxin Warfare Convention, the reference to weapons of mass destruction remained the focal point of the resolution. For many UN inspectors in the biological area, it was unclear whether the interpretation of weapons of mass destruction included biological agents for clandestine purposes such as assassinations or "dirty tricks". Although many biological agents can be used for either a military programme or for assassination purposes, there is a large difference in the scale of operations. The mandate included reference to weapons of mass destruction, which is usually interpreted to mean killing hundreds or thousands, and for some UN inspectors this mandate did not include the right to inspect undeclared intelligence-related sites even though Iraq was obliged to declare the possession of any listed micro-organisms or toxins regardless of quantity. UN inspectors were focused on militarily significant quantities of agent produced or weaponised. Later on, UN inspectors did include undeclared intelligence-related sites for inspection especially after the defection of Lt. General Hussein Kamel in 1995 after Iraq admitted concealment.

What appears to be missing is an implementation document in particular for Security Council resolutions 687 (1991) and 715 (1991) beyond the report of the Secretary General (S/22614) which set out only broad concepts of operations. It is usual for any obligation to have an accompanying implementation strategy and instruction – for example spelling out in detail the implementation methods and strategies for rendering

harmless infrastructure, what dual use items are to be destroyed and what items or components can be spared and where the line is drawn between WMD and conventional weapons.

Lesson: Where to draw the line?
It should be clear in any mandate where the various parameters and boundaries are drawn. This in turn requires specific delineations and definitions that may be hard to compose but by not doing so, it pushes the responsibility of interpreting the mandate, down to the inspectors. Implementation documentation (similar to what many national governments construct when implementing international agreements such as the CWC) is a necessity so that there will be consistency and no confusion as to exactly how the mandate will be implemented by inspectors in the field.

The Biological Inspection teams

The Team Composition

UN biological inspection teams prior to the year 2000 were composed of members who were nominated by their governments. The various supporting governments nominated experts who had scientific backgrounds and who had experience and training in biological warfare research or defense. It was not always possible to assemble a team with a range of expertise that might be required for a particular inspection such as fermenter operators, process engineers, experts who had hands on experience with drying biological agents, pharmacists, veterinarians, genetic engineers, medical researchers or biological weapons experts.

The initial UNSCOM biological inspection teams were comprised of experts in biological warfare and biological defence related areas and were highly qualified and highly skilled. The teams – while being composed of some of the best scientists and engineers in the field with a very good and broad knowledge of BW – did not have hands-on expertise in the declared industries that they were inspecting. It may have been very useful therefore to have diversified expertise within the inspection teams, comprising not only trained experts in the WMD field, but also specialists in scientific and technical areas relevant to specific activities. For instance, inspection teams visiting declared industries (such as pharmaceutical or vaccine industries) should comprise industrial experts with knowledge of production techniques and processes in these industries and not just BW experts.

To some degree, the UN inspection agency has learnt lessons from the past and UNMOVIC has tried to establish a solid core of inspectors who have academic as well as practical experience in microbiology (such as bacteriologists, virologists, toxicologists and immunologists), biochemistry, genetic engineering, and industrial production and downstream processing technology. In addition within the roster of personnel, UNMOVIC tried to maintain a balance between those with academic research skills, those with pilot-scale or bulk production hands-on experience in the vaccine, pharmaceutical or food and beverage processing industries and those with weapons and WMD defence-related backgrounds. It proved beneficial to UN inspections in 2002-2003 to have experts with industrial experience as part of the inspection teams.

Lesson: Take an industry expert
Inspection teams should include, whenever possible, scientific/technical experts with hands-on experience in the industry that is being inspected. Although techniques, standards and methods may differ between countries, generally the principles of production are the same. Such expertise will give credence and balance to judgments and assessments of capabilities and current production. Having such expertise as part of an inspection team is a necessary but not sufficient condition for a thorough inspection.

Perceptions of inspectors

Considerations related to the lack of biological containment were major factors in the initial perception of the unsuitability of Iraq's dedicated biological weapons production facilities for the production of pathogens. These considerations were drawn from microbiological and manufacturing practices and standards familiar to the inspectors, who were experts on biological weapons.

The assumptions regarding the unsuitability of Iraq's dedicated biological weapons production facilities were reinforced by the lack of evidence at the time that Iraq had progressed beyond research and development of biological warfare agents. In the absence of such conclusive evidence, it was difficult to conclude that Al Hakam was a biological weapons production facility or that Iraq had produced bulk agent or had biological weapons, until 1995. As was subsequently explained by Iraq, it produced liquid bacterial biological warfare agents accepting a moderate risk of airborne contamination.

Lesson: Safety Standards Differ
What did not seem possible at first as an environment for producing biological warfare agents because of the lack of safety practices and the unsuitability of the equipment and infrastructure was later declared as used for the bulk production of liquid biological warfare agent. The lack of containment and safety were only some of the factors that influenced inspectors to make their conclusions. These factors however, seemed to have carried considerable weight. The lesson from this is for inspectors to bear in mind what is possible not what is ideal or acceptable.

The views of UN biological inspectors who inspected Al Hakam for the first time in 1991 differed. Some team members strongly suspected proscribed activities had occurred while others apparently were sufficiently confident that this was not the case. These differences were only partly reflected in the inspection report and particularly in its Executive Summary.

The Executive Summary of the UNSCOM 15/BW-2 inspection report concluded that *"the team was successful in determining with confidence the current functions of all 10 sites visited and is reasonably assured that past activities did not differ."* With regard to Al Hakam, it states that "*there is absolutely no evidence of participation in a biological weapons program"*, but concedes that there were concerns *"that it might feature in the development of such a program."*

In contrast, the Debriefing Report prepared by UNSCOM 15, states with regard to Al Hakam: *"The UNSCOM team assessed the facility to be highly suspicious. The team was not convinced by the documentation, plans, or equipment found at the facility that the work at Al Hakam would conform to an SCP project."*

While both assessments ("*absolutely no evidence*" and "*highly suspicious*") are not contradictory in an analytical sense, they do convey quite different messages. It can be hypothesized that the wording of the Executive Summary strongly influenced decision-making and prioritization of follow-on activities within UNSCOM.

While it was possible to gather enough information to cast serious doubts on the Iraqi cover story, all of the evidence was circumstantial which alone may not have been enough to make a 'firm' or unqualified judgment. There is a huge gap between having suspicion and having proof positive and UN inspectors were aiming to go beyond just having doubts or suspicions in their presentations to the Security Council.

The inspection reports of the early UN missions do not provide comparative assessments. Many of the suspicious features of Al Hakam were explained as 'typical' for an Iraqi environment, while at the same time Dora did not have these features such as enhanced security or a military type layout. A comparative assessment of all these features for all similar sites (that is biological production sites) may have further underlined the uniqueness of Al Hakam.

In other areas of reporting and assessment, there seemed insufficient weight given by chief inspectors to the likely cultural behaviour of Iraqis and the effect that this would have on work ethics and productivity. For example, when estimating the likely production of agent at Iraq's BW facilities, UN inspectors took into account factors such as growth media, equipment and personnel availability and theoretical time needed for batch runs of agent. Although this approach may have provided a "possibility" of production, insufficient weight seems to have been placed on "most likely" production given productivity levels in Iraq.

In general, under UNSCOM, reports from the field missions were reports of the chief inspectors. It was the chief inspector's responsibility to make sure that the data was correct and reflected what had occurred during the inspection. Although dissenting views could be aired prior to the final report, the conclusions and assessments were predominantly those of the chief inspector since it was he/she who had to bear the responsibility for what was included and the conclusions made. In its short period of operations in the field, UNMOVIC tried to have more of a collegial input into a factual report and giving appropriate weight to the particular subject experts on particular topics. This approach was in recognition of the fact that the chief inspector was not a master of all topics and biological disciplines (from research and development through production, downstream processing, weaponisation and dispersion to financial, organizational and technical aspects) and that the assessments and conclusions should reflect those best qualified in the area. The final responsibility for the report however, rested with the chief

inspector and the chief of the biological Planning and Operations Division. Further assessments and conclusions were made by the biological Assessment and Analysis Division.

Lesson: Reflect different perspectives

The chief inspector's report to the Executive Chairman did not always reflect the views and concerns from other inspectors in the team. The inspection team gathered no conclusive evidence of biological agent production at Al Hakam during their first visit to that facility but did raise a number of concerns and suspicions. Different views within an inspection team should be fully included in the inspection report and also in the Executive Summary of the report. Had the alternative concerns been articulated and included in the Executive Summary, additional inspections may have followed more quickly.

A system of clearly defined confidence levels (such as "evidence", "probability", "possibility") for use in reporting and communication should have been established and used coherently in reporting, to avoid loosing important assessments below the "evidence"-level, while at the same time avoiding unjust judgments or unnecessary strong language in official documentation

Differences in assessments of sites inspected should be highlighted in inspection reports.

Inspection reports should provide comparative assessments.

Operational Aspects

Timing of inspections

During the course of the initial inspections in Iraq, particularly for the biological group, the timing of inspections turned out to be an important element. From the adoption of resolution 687 (1991) until the commencement of biological inspections, Iraq had time to eliminate much of the evidence of past activities at facilities used in its biological weapons programme. As an example, Al Hakam was declared by Iraq in a letter from 22 May 1991 as a site "to produce vaccines or other materials produced by micro-organisms such as single cell protein", but the facility was only inspected for the first time in September 1991. This left abundant time after the ceasefire for Iraq to decontaminate, paint, plaster and reconfigure Al Hakam.

The initial UN teams were working with limited resources and under strict time constraints, thus requiring a careful selection of inspection targets. As the possibility of a BW production site at Al Hakam rated much lower than pressing issues such as the destruction of CW or long-range missiles, the delay in uncovering Al Hakam to a great extent may be attributable to resource constraints and much less to shortcomings in the inspection process.

Thus, prompt commencement of inspection and verification activities at newly declared or identified facilities is essential, especially for biological inspections. A prompt inspection presupposes the availability of qualified and trained inspectors for deployment

at short notice, and established inspection procedures and protocols such as for sampling and analysis.

Timing is also crucial for sampling and analysis – at Al Hakam Iraq had time to decontaminate and take other measures, which added to the difficulty of obtaining positive samples.

Lesson: Look widely at all declared facilities
A major lesson from the biological inspection process is the need to inspect all declared facilities quickly and do extensive sampling. Rapid and thorough inspections are only possible with a standing team of diverse and trained experts that are ready to go with little advanced notice.

Fixed and adequate resources should have been allocated to biology as much as other disciplines.

Legitimate facilities

The Iraqi experience has shown that legitimate civilian facilities can be used at different stages of a WMD programme (see Table VIII.III).

Table VIII.III Examples of civilian and legitimate facilities, outside of the military sector, involved in the BW programme of Iraq.

Facility	**Involvement in BW programme**
Universities and Institutes	
University of Baghdad, Baghdad University of Mustansiriyah, Baghdad	Acquisition of some bacterial isolates. Educational site for personnel.
University of Technology, Baghdad	Educational site for personnel. Involved in design of facilities.
Ameriyah Serum and Vaccine Institute	Temporary storage of bacterial isolates in 1991.
Institute of Technology, Baghdad	Educational site for personnel.
Technical Medical Institute	Supply of personnel.
Health-related Agencies and Facilities	
Rasheed Central Military Hospital Iraqi Health Service Laboratory Iraqi Veterinary Central Diagnosis Laboratory	Acquisition of some bacterial isolates.
Production Facilities	
Al Kindi Veterinary Vaccine Production Company	Source of fermentation and support equipment Training of personnel
Foot and Mouth Disease (FMD) Vaccine Plant Center for Agricultural Research and Water Resources	Production of BW agents
Supplying and/or Manufacturing Companies	
Al Khalij Company	Source of equipment
Babel Electricity Directorate Yamiks Company	Involved in building infrastructure.
Banks	
Central Bank of Iraq Rafidain Bank	Involved in procurement.

As mentioned in more detail in Chapter V, an important lesson learned by the UN inspection teams was the importance of examining commercial facilities capable of supporting a proscribed programme. As shown by the example of the Foot and Mouth Disease Vaccine (FMDV) plant at Dora, inspectors concluded without full verification that the activities were legitimate. After the defection of General Hussein Kamel from Iraq in August 1995, Iraq admitted that biological warfare agents had been produced at two civilian facilities, the FMD vaccine plant at Al Dora and Center for Agricultural Research and Water Resources at Al Fudaliyah. With regard to FMD vaccine plant, the inspectors who visited the plant from September 1991 to 1995 identified the site capabilities for the production of biological warfare agents, but concluded that the site was a legitimate facility since no modification to its original design was observed. No indication of its involvement in Iraq's biological warfare programme arose until in August 1995 Iraq declared its past involvement. Since the production log book and samples of equipment at this facility were not obtained prior to 1995, the evidence of its involvement was not uncovered prior to Iraq's declaration.

Lesson: Minor changes might mean something big
BW agent was produced on a large scale in a legitimate civilian facility. The usage of the facility for BW agent production remained unnoticed by UN inspectors until sampling was performed after the defection of General Hussein Kamel.

A purpose-built vaccine production plant constructed by a foreign company is no guarantee that activities are always legitimate. Also, visits by members of international organizations cannot be taken as an indicator of the absence of illegitimate activities.

If a site is configured in exactly the same way as it was at the time of construction, it does not mean that this was the case throughout the whole time of its existence. It might have been reconfigured for BW purposes, and changed back thereafter. Minor modifications can go undetected, or can easily be explained by the inspected party with simple cover stories.

The conversion of a legitimate facility may be hard to detect. Only very minor adjustments are needed for the production of BW agent. However, investigative forensic sampling will most likely reveal past activities.

In hindsight, and in theory, a few leads could have indicated that FMD vaccine was not all what was produced at the FMDV plant in the past. These leads, however, were probably very difficult to detect and can hardly be considered clear 'signatures' of such a diversion.

The UN inspectors were also not aware of the involvement of Al Fudaliyah in Iraq's BW programme, and did not conduct sampling and analysis during their inspections of that site.

In the absence of sampling and analysis, finding the evidence to uncover Iraq's BW programme was difficult. While modern analytical and detection techniques have

advanced significantly in recent years, so too have advancements in technology which could make detection much more difficult, such as “clean-in-place” capabilities and disposable production systems, thus presenting new challenges for the future.

Although most staff involved in the production of BW agent at Dora came from Al Hakam, all staff at the FMDV plant must have been aware of changes, in terms of ownership of the site (payment of salaries) and in terms of production activities (new walls built in several areas of the site). These staff was never subjected to questioning by the UN inspectors.

Lesson: Thoroughly inspect capable biological facilities and sample extensively

In order to increase the chances of detecting a transient conversion of legitimate facilities, future inspection regimes should thoroughly sample production equipment with no or minor modifications, even in the absence of any suspicions about a particular site.

Nature of the BW programme

The BW programme, while in the early stages of its development, was closely linked to the CW programme. This is not uncommon with other countries that have had both CW and BW programmes. BW programmes have also relied heavily in their early development, on the CW programme for field-testing and weapons development. However, at some stage the BW programme outgrows its symbiotic relationship with its chemical counterpart both in its needs for dedicated large-scale production facilities and for the development of specialized munitions. The BW programme was different in one aspect from that of the CW or long range missile programme in that Iraq used civilian facilities both for pilot-scale production (Al Taji) and later for surge capacity (FMDV and Al Fudaliyah) to supplement its dedicated BW facility at Al Hakam. If allowed time, it is likely that Al Hakam would have expanded to consolidate all BW activities.

Lesson: Be Flexible
A fledgling BW programme could easily be co-located in a chemical complex as was the case at Muthanna and so too pilot-scale or specific agent research or production could occur within civilian industries. Inspectors should pay attention to all types of facilities regardless of the admission of a full BW programme or not.

Verification in the biological area is inherently as complex as in the chemical or missile areas. In the biological and chemical area the production equipment and materials are dual-use and therefore there are no unique features or markers that point unambiguously to proscribed activities.

Sampling Policies

The importance of sampling for biological inspection activity has been mentioned in great detail throughout Chapter V. Provided that the sampling methods are carried out following strict standard operating procedures and that chain of custody principles are adhered to, sampling provides objective data which can be critical for verification.

The experience from UN inspections seems to indicate that having a specialized group of inspectors trained and designated for sampling was the appropriate strategy. In many early UN inspections, a specialized team would be sent on a sampling mission where as during the UNMOVIC inspection period, trained specialists were an integral part of each biological inspection team. Having trained inspectors is the best method of ensuring that samples are taken consistently and in the correct manner. There is less chance of samples being contaminated or cross-contaminated if well-rehearsed practices are employed. Underlying correct sampling, are procedures that should be specific and comprehensively embodied and articulated in written Standard Operating Procedures (SOPs). The SOPs are a pre-requisite and should include guidelines covering where to sample both forensically and environmentally and where and how many samples to take. Also underlying successful sampling was the development of a standardized sampling kit that was suitable for a wide range of solid and liquid chemical and biological samples.

UN inspection experience also suggests that many lessons were learned over the years with regard to samples taken and analyzed. For example, it was mentioned in Chapter V that the first biological inspection group in August 1991, took samples only in bunkers adjacent to 'Area A' at Salman Pak, but in none of the buildings – destroyed or not – of the Forensics Department (Figure VIII.II). With regard to sampling, the inspection report says at one point: "*The only laboratories still standing were those which had reportedly been used for testing of food and drink for human consumption. These laboratories had been cleared of all equipment and cleaned. It was decided that there was no purpose in taking any samples from any part of this building*." Contrary, we know now that the possibility of finding BW agent signatures would have been significant.

Figure VIII.II Damaged Building at Salman Pak August 1991

Also the remains of the destroyed inhalation chamber, or the environment around the putative site of the inhalation chamber building were never sampled (Figure VIII.III). This highlights the need for abundant sampling at all locations on a site regardless of the declared purpose especially during the first phase of inspections in a new environment when no knowledge about the range of possible BW agents involved is available.

Figure VIII.III Destroyed Inhalation Chamber, Salman Pak August 1991

When the second biological group inspected Al Hakam for the first time in September/October 1991, a limited number of samples were taken and analyzed. Samples were taken from the 150 litre fermenter that was previously at Salman Pak as well as from other production equipment. Even with the limited sampling analytical technology at the time (culturing, ELISA and basic PCR) more extensive sampling could have revealed some evidence of illicit activity.

UN inspectors did not sample the dumps site at Al Hakam until it was declared in 1995 and had it been done in 1991 again it may have led to some more conclusive evidence of illicit activity. The above examples point to the need for comprehensive forensic and environmental sampling procedures.

Samples were not always split or saved and these lessons derived from early UN inspections were incorporated into the sampling procedures of UNMOVIC. In addition, UNMOVIC applied the principle that the UN maintained ownership of these samples regardless of where the analysis was performed. With the rapid development in biotechnology, diagnostics and analytical laboratory techniques throughout the 1990s and to 2007, much more data is available now from historical samples than was available at the time the samples were taken. The advancing technology suggests that samples should be preserved for at least 10 years so that confirmatory analysis can be done at a later time, if needed. The use of accredited reference laboratories and cross examination of samples by at least two laboratories proved invaluable in providing a high degree of confidence in analytical results obtained.

Sampling is not without cost, both the taking of the samples and the transportation to screening and reference laboratories as well as the analysis itself. The costs of sampling have to be weighed carefully against the benefits of obtaining objective and precise results.

Lesson: Some "musts" for sampling
Sampling proved a very valuable tool for UN inspectors. The sample procedures and practices were improved over the course of inspections from 1991 to 2003. However the lessons for UN inspectors can be summarized as follows:

a. Have specialized and trained sampling team members integrated into the inspection teams so that sampling can be done on any inspection.
b. Develop, practice and test the SOPs that will be the guidelines for inspectors in the field to collect, handle and screen samples.
c. Take numerous environmental and forensic samples particularly when visiting a capable facility for the first time using probability sampling when possible.
d. Where possible, split the samples at least three ways such that one is kept by the UN inspection team, one is given to facility in question and one sample is available for a reference laboratory.
e. Keep samples for at least 10 years and maintain ownership of them.
f. *Have in place a field-screening laboratory fully equipped and staffed. Also have in place a system of accredited external and independent reference laboratories.*
g. *Assemble standardize sampling kits which meets the requirements\e for most types of chemical and biological samples.*

Annex: Mapping A Biological Weapons Programme

Structure of the programme

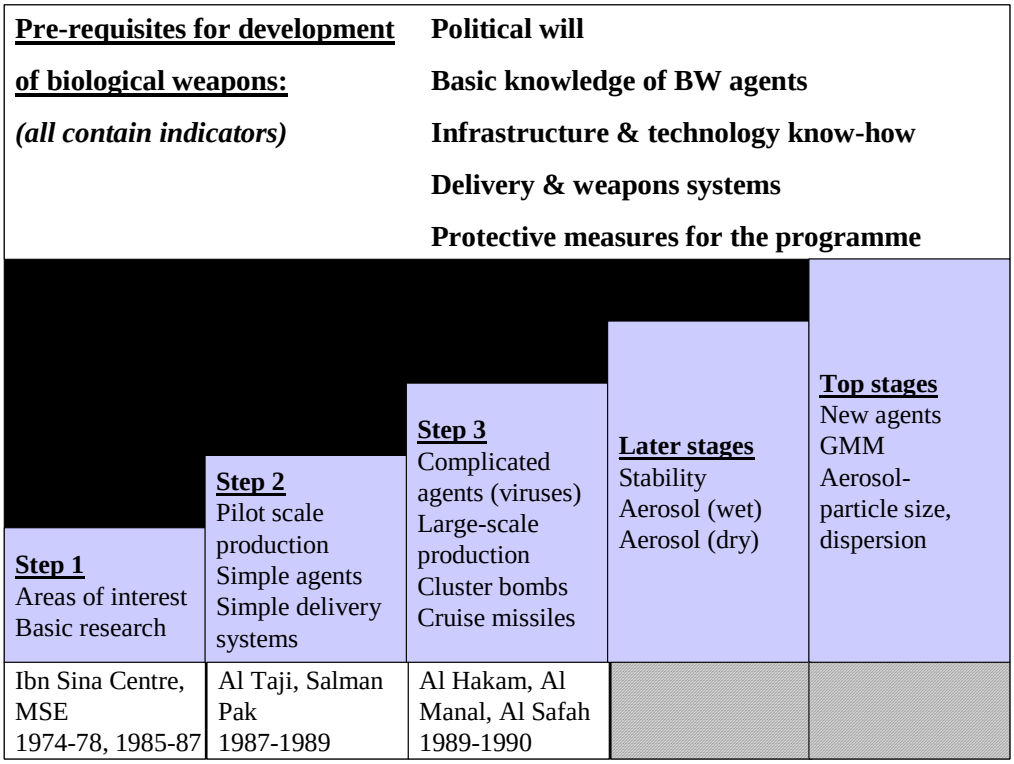
Components of a BW programme in general

The border between BW defensive and offensive activities is difficult to define especially at the early stages of a programme. Many of the components of a defense research programme and an offensive programme are the same. There are well-equipped laboratories, for instance for the cultivation and harvesting of microorganisms. However, in general, a more pronounced large-scale dimension compared to a defense research programme characterizes an offensive biological programme of a state.

To build a state funded BW programme, several components or factors have to be in place (Figure VIII.IA). Firstly, political will must exist within the leadership. This could be expressed in several ways such as in a state doctrine demonstrating a clear offensive or deterrent strategy, expansionistic ambitions or strive for regional hegemony, strong relations on a high political level with other states of concern, negative asymmetric position towards a threat, and the attitude the country displays and how it acts with respect to international conventions. Statements made by high officials regarding WMD and its impact on present or future security problems, including the state's rights to acquire any means to defend themselves, could be another expression of political will.

Secondly, the basic knowledge of BW agents has to be acquired. This comprises the combination of knowledge of the critical properties of infectious agents and the means to test and maintain these properties. There are a number of organism related factors that have to be addressed, such as: the optimal methods for cultivation with retained infectivity or toxin production, the proper methods for harvest and preparation, the infectious characteristics of the bacteria or virus of interest, the average time from exposure to illness, the contagiousness, and the physical stability of the organism.

Figure VIII.IA. General structure of a BW programme



Thirdly, the infrastructure and technology know-how must be developed. Production technologies for classical biological agents are well known, and many countries have a civilian biotechnological industrial profile of dual-use character that would serve to produce biological agents. Biotechnology has also brought more efficient methods for growth of microorganisms and the same knowledge is a benefit in an offensive programme. As a result of the more efficient methods developed for the production of pathogenic microorganisms, more species can be artificially grown in a laboratory. Likewise, many components of a legitimate defense research programme and an offensive programme are the same. The main difference is the large-scale dimension of an offensive programme. The fermenters in the offensive programme have pilot scale or even of large-scale capacity.

Important for the build-up of a capability is the acquisition of material and equipment. In the previous decade most states have introduced stronger export restrictions in order to make it more difficult for proliferators to import equipment suitable for offensive programmes. As a result of the expanded export restrictions and the subsequent problems to import equipment, a growing number of states strive to gain a national capacity for manufacturing of dual-use production equipment.

Key-personnel employed at an offensive site are educated and trained in relevant areas, abroad if the desired knowledge is not available domestically. They are well paid and the ethnic diversity is typically limited.

Fourthly, delivery and weapons systems have to be developed. An agent does not become a usable weapon until it has been integrated with some type of weapon system. Suitable munitions or delivery systems need to be procured, developed or modified and there must be equipment and procedures for the filling of weapons. Development of delivery systems must be supported by a logistic system for the stockpiling, transport, handling and use of bulk agents and munitions (including explosives), and production and weaponisation must be complemented by dispersion trials to test prototypes.

Fifthly, protective measures have to be undertaken for several reasons: to protect the resources from being revealed, and for economic relations and funding of the programme. A country with an offensive programme will need to protect its assets from being revealed. Thus, a production or offensive research facility usually has a high level of secrecy, at least for part of the facility. It will have restricted access, high security and safety levels, guards, military personnel, fences, cameras, motion detectors etc. There may be reasons for locating a facility within a concealed programme in a remote area, but on the other hand a civilian site located in a city may attract less attention and serve as a cover for offensive activities.

Given the sensitive character and military interest in a BW programme, important facilities and chemical and biotechnical industries would be under military or state influence. In a situation where defense projects have a high priority in state affairs, they would be funded over the state budget.

In general, past BW programmes of different countries were running through different stages of development (Figure VIII.IA), with an increasing degree of sophistication:

- Step 1, initial period: Assessment of the areas of interest and basic research,
- Step 2: Successive development of an infrastructure for offensive work. This is exemplified by the introduction of a pilot-scale production of the agents simplest to handle and produce, along with the development of simple delivery systems,
- Step 3: More complicated agents, such as viruses, are introduced into the programme. Large-scale production commences. At the same time the technological level of delivery systems will increase from simple artillery bombs to cluster bombs and cruise missiles,
- Later stages: The stability of the agents is an issue of concern, and various methods are developed with the purpose to increase the stability of biological agents as aerosol. Later the interest is shifted from wet aerosol to dry aerosol dispersion techniques, and
- Top stages: New agents or genetically modified microorganisms (GMM) are found in the programme, and the actor has established know-how in aerosol production, optimal particle size and dispersion models.

There are usually links between the biological and the chemical programmes in the form of information exchange between laboratories located at the same site, or using the same supporting facilities. A review of past offensive programmes indicates that usually the chemical is initiated before the biological programme. In particular, the biological programme is believed to benefit from experience gained within the chemical programme.

How the Iraqi BW programme Fitted This Map

The different stages that generally are found in an offensive biological programme were also found in the Iraqi programme (Figure VIII.IA).

Political Will and the Strategic Environment

The Ba'ath Socialist Party and Saddam Hussein

The Iraqi Ba'ath Socialist party was formed in 1949, as a cell of the global pan-Arab nationalist movement shortly after the defeat of the Arab Forces in Palestine in 1948.

In 1957 Saddam Hussein joined the Ba'ath Party. Two years later he was involved in an unsuccessful attempt to assassinate General Abdul Karim Quassim, who had led the overthrowing of Faisal II in 1958. Saddam Hussein fled to Tikrit, and then to Egypt via Syria and Beirut. Saddam Hussein was to remain in Egypt until 1964.

Quassim was overthrown in a coup 1963, and Abdul Salam Arif became president. Arif dismissed and arrested the Ba'athist leaders, and Saddam Hussein who had returned to Iraq was imprisoned in 1964. Saddam escaped prison in 1967, and became a leading member of the party. In 1968, the Iraqi Ba'ath Socialist party seized full power in Iraq; Ahmad Hassan al-Bakr was named president and Saddam Hussein was named his deputy.

The party's major priorities became more focused on domestic reforms rather than on pan-Arab issues.

In 1976, Saddam Hussein rose to the position of General, and became the strongman of the government. Saddam Hussein took an increasingly prominent role as the face of the government, and became the architect of Iraq's foreign policy and represented the nation in all diplomatic situations. He formally came into power in July 1979.

Iraq and WMD

Before Saddam Hussein gained power, Iraq did not possess chemical, biological weapons and ballistic missile capabilities. The decision to acquire unconventional weapons was taken just after he came to power. According to Lt. Gen. Amer Al-Sa'adi, senior deputy director of MIC "*it was during the 1970's that the Iraqi government provided extra resources to the military, in an attempt to upgrade its weapons systems to counter these ever present threats (*traditional threats from Iran and Israel). *There was a 5-year plan directed at establishing the necessary structure to produce conventional weapons and conventional ammunitions (through licenses from other countries, commercial joint ventures and government-to-government agreements). The second objective was defined*

in a second 5-year plan later, to establish R&D in all disciplines in order to enhance the productive capability – both horizontally and vertically – using already existing resources or defining new ones".

There were several important factors that influenced the development of weapons programmes at different times such as the bombing of the Osirak nuclear plant in 1980/1981, the various Arab/Israeli wars, the Iraq-Iran war, and the existence of other non-conventional capabilities in the Middle East.

According to the ISG report "Saddam felt that any country that had the technological ability to develop WMD had an intrinsic right to do so. He saw WMD as both a symbol and a normal process of modernity. Saddam's national security policy demanded victory in war, deterrence of hostile neighbors (including infiltration into Iraq), and prestige and strategic influence throughout the Arab world. These concerns led Iraq to develop and maintain WMD programs".

The first interest in CW was expressed by Iraq's Ministry of Defense in1971, when a chemical laboratory complex to obtain practical experience in the synthesis of chemical warfare agents was established

1973 war between Israel and Syria

The outcome of the 1973 War led Iraq's Armed Forces to re-evaluate Iraq's existing military capabilities. This resulted in Iraq's decisions to look into the possibility of the acquisition of strategic weapons systems and delivery means, including biological and chemical weapons and ballistic missiles. According to documents issued by the former Iraqi leadership available to UNMOVIC, Israel was considered as a major potential enemy of Iraq in the region and was referred to as the Zionist entity.

In 1973, the Arab-Israel war sparked further interest towards the acquisition of a chemical and biological warfare capability. In 1974, the Al Hazen Ibn Al Haitham Institute was created to conduct scientific, academic and applied research in the fields of chemistry, physics and microorganisms. The new organization was attached to the Ministry of Higher Education and Scientific Research but was in reality affiliated to and run by the State Intelligence and Security Apparatus. It was also supported by the Ministry of Industry with regard to the construction of its infrastructure and the acquisition of necessary technology, equipment and materials.

The 1980s Iran-Iraq war

The Iran Iraq war, where Iraq's Forces faced overwhelming domination by Iran in manpower sparked large-scale production and deployment of chemical weapons by Iraq. The extension and complications of this war led Iraq to the development of ballistic missiles with the range up to 600 km to enable it to reach strategic targets in the depth of the Iranian defense.

In 1988, shortly after the Iran-Iraq war, the war assessment made by the former Iraqi leadership materialized in further attempts by Iraq to create more powerful types of chemical and biological weapons and long-range ballistic missiles.

Early in the second half of 1988 when the war with Iran was about to end and shortly after, Iraq's high-level authorities created a foundation for further development of chemical weapons. It was proposed by Iraq's MOD in a letter to the President dated 20 July 1988. The following two excerpts reflect the main idea of that document: *"The possession and development of chemical and bacteriological weapons by our country are considered the best weapon to deter the enemy in this domain"* Further, the letter goes on to describe active measures that should be undertaken, first of which was: "*Develop and expand the chemical weapons, both quantitatively and qualitatively in terms of munitions, delivery methods and storage, according to the capabilities made available by the Military Industrialization Commission*"[8]

Based on its experience from the war with Iran, Iraq considered chemical weapons as an important factor in building its predominant role in the Middle East and also as a deterrent against potential enemies. Chemical weapons were seen as a kind of protecting shield of national security and one of the prerequisites of its domestic stability. After the war with Iran, Iraq developed the conviction that chemical weapons are an effective way to supplement and magnify conventional combat means. But it was still considered as a supplement but not the main factor of military potentiality.

One of the reasons, which induced Iraq to use chemical weapons against Iran were the so-called "human waves" that, according to senior Iraqi officials, couldn't be dealt with conventional weapons. This meant to explain, in Iraqi terms, how Iraq tried to overcome overwhelming dominance of Iran in manpower during the war. But, as it was noticed by several observers, and was eventually confirmed by Iraqi officials later, Iraq did not consider chemical weapons used during the Iran-Iraq war as a kind of weapons of mass destruction but rather saw it as a supplement to conventional weapons in achieving specific tactical and operational goals. As it is known from various reports, various military units such as artillery positions, command posts and logistics bases were among frequent targets of Iraq's CW attacks.

The BW programme

In its 1997 Biological Full Final and Complete Disclosures (FFCD), Iraq stated that "*The underlying motives behind Iraq's efforts to initiate BW studies and to possess BW weapons were always the fear that Iraq's enemies in the region were actually developing such weapons or in fact possessing weapons of mass destruction*".[9]

According to the Iraqi CAFCD (Chapter 10, p 261), the strategic objectives of the programme were always the need to possess a viable deterrent against external threats in the area by those who are known to possess weapons of mass destruction in the three

[8] UNMOVIC Document No 902024
[9] Biological FFCD September 1997 page 12.

known areas, nuclear, chemical and biological weapons of mass destruction. This has also been stated by General Al Sa'adi in interviews (UNSCOM 253/BW 70, Dec 1998. pp 53, 74). He has also stated that the BW weapons were developed with the aim of using them as strategic weapons, and that the BW programme was a stop-gap programme until the nuclear programme had achieved its goals (UNSCOM 253/BW 70, Dec 1998. pp 54, 76, and TEM Vienna, March 1998, Section 3 "*Sites*").

The efforts made for possessing such a capability started with the creation of a study group to gather information and conduct initial studies and to help chart the way for further work. There was no master plan for each activity, nor definite design requirements for a specific weapon. The experience had to be built step by step as there was no open literature or ready-made package of expertise that could be procured. Also for security considerations foreign assistance was not sought for the development of the programme.

When in 1988 -1990 some agents were selected and produced upon decisions taken at the level of the biology group and the approval of the management at the establishment level and MIC level, the work on weaponization began with input from CW weaponization group at MSE. It is to be remembered that MSE leading personnel were mainly trained officers from the chemical corps i.e. the military aspects of the programme was available from within MIC (CAFCD, Chapter 10, p. 261).

In 1988, the Iraqi Ministry of Defense recommended that MIC should be tasked to initiate BW studies in response to Israel's programmes of WMD, as reported by the Arab League report on Israel's activities and achievements in the field of nuclear, chemical, and biological warfare capabilities. That recommendation indicates clearly that MOD had no knowledge of the then current BW activities at TRC (CAFCD, Chapter 9, p.239).

Basic knowledge of BW agents and production

NBC Defence activities

NBC defense is a legitimate area of military activity aimed at protecting troops and civilian population from potential nuclear, biological and chemical threats. Naturally, such activities require specific knowledge of these weapons, their combat characteristics and properties. By the end of the 1960s such general knowledge had been gained by the Iraqi Chemical Corps, formed within Iraq's Armed Forces on 14 January 1964. Educational and training programmes with respect to biological and chemical weapons had covered a variety of subjects. These included the properties of chemical and biological warfare agents, their medical effects, and identification and detection methods. Usage of individual and collective protective and decontamination equipment, and appropriate prophylactic measures were covered as well.

The 1970s early BW programme, basic research (Step 1)

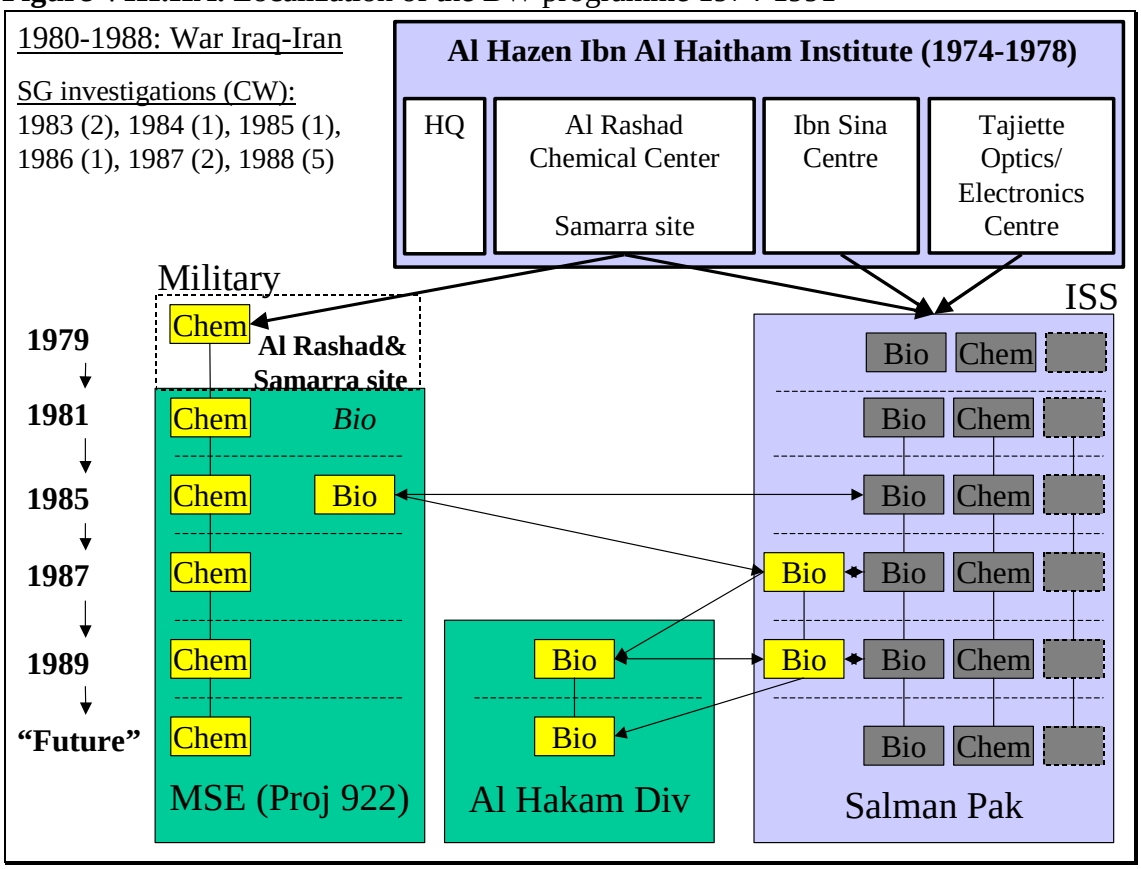
Although the biological work was initiated by Iraq in the 1970s, at that stage it was focused on general research into the basic parameters and characteristics of different

microorganisms but, in general, not exclusively those traditionally associated with biological warfare. As part of the programme, Iraq constructed a dedicated research facility, the Ibn Sina Centre, located on the Salman peninsula near the town of Salman Pak, some 30 km southeast of Baghdad. The Ibn Sina Centre came under the auspices of a newly created organization, Al Hazen Ibn Al Haitham Institute, which was in turn subordinated to the special security and intelligence agencies (Fig. 2). However, this first attempt to establish a biological weapons programme in Iraq came to a halt in 1978, when the Institute was shut down by the Government for the stated reason of having achieved poor results.

Fate of BW research after 1978

In the CW programme, after the abolition of the Al Hazen Institute, Al Rashad was returned to the Chemical Corps and the Samarra site was placed under the control of SOTI (Figure VIII.IIA). According to Iraq's declarations, the Chemical Corps continued to operate laboratories at the Al Rashad site, and from 1979 to 1981 civil construction and development of the Samarra site (with all its equipment and materials procured for four CW production plants by Al Hazen Institute) was continued by SOTI as Project 1-75. In 1981 Project 922 was established within the Ministry of Defense. The Project inherited the assets from the Al Rashad chemical laboratory complex, as well as the partially completed Samarra site (later known as MSE).

Figure VIII.IIA. Localization of the BW programme 1974-1991



There is no evidence whether any work in connection with biological warfare was conducted immediately following the closure of Al Hazen Ibn Al Haitham Institute. It is known that staff employed by the abolished Ibn Sina Centre were instrumental in building up what would become the Forensic Research Department of TRC. Moreover, from Iraq's declarations and interviews with Iraqi scientists, it is clear that some biological activities continued at Salman Pak under the auspices of the security apparatus (Fig. 2). At the end of 1984, such activities included investigating using wheat smut as a possible weapon's agent that would cause economic loss.

The BW programme showed rapid development; from the re-start in 1985 to pilot-scale production in early 1988 and large-scale production at Al Hakam Factory in early 1989 (see following paragraphs). This has been puzzling since under the circumstances at the re-start of the BW programme in 1985 - a totally new and inexperienced staff, non-dedicated facilities and no familiarity at all with BW agent production - slow progress within a new BW programme would be expected. The rapid progress has caused speculation regarding an earlier re-start of the programme, perhaps at the Al Taji SCP plant, which would have allowed for more time allocated to basic research and development. Alternatively, there could have been an information flow from a biological programme running under the auspices of the security apparatus.

There are implications that the Forensic section of the STRC was engaged in research other than that for food safety and regime protection. Besides the research on wheat smut, there appears to be inconsistencies between what Iraq has declared with regard to both the construction and other activities that occurred at the site. For food and water contamination analysis it is unlikely that an inhalation-testing chamber would be required or that such standards for the building specifications were necessary. Also, a large cold storage facility at the site was probably not intended to hold chemicals, as declared by Iraq, but most likely to store biological material. Being under the umbrella of the intelligence and security apparatus, it seems likely that some research was conducted on behalf of the intelligence services (so called "dirty tricks" activities). If a biological programme was indeed running under the security apparatus, it is probable that it included research on botulinum toxin and ricin, as well as wheat cover smut.

Offers for considerable quantities of culture media were issued through the T-3 section of TRC in January 1987 when, according to Iraqi declarations, the T-3 section was just a few biologists working on screening water and food samples for contaminants. This media acquisition by T-3 is puzzling and suggests that either the MSE BW group had already made a transition to the Salman Pak facility, that they were already anticipating it, or that more activity was occurring at Salman than declared.

The presence of a biological programme under the security apparatus has been corroborated by the ISG. In their report they concluded that the STRC (later called TRC) was created in 1979 as a technical support agency for the IIS and to replace Al Hazen as a cover mechanism for work on chemical and biological agents. The IIS continued small-scale research CBW activities with some personnel from the Al Hazen Institute, and

recruiting chemists and scientists from universities and private laboratories and assigning them to Al Salman. At the time when the military BW programme started at MSE, Al Salman under the authority of the intelligence services was conducting a parallel BW research programme, including wheat cover smut and the development of a spray device for bacteria.

The BW programme restart in 1985, basic research (Step 1)

Military interest in the development of the biological weapons programme was first expressed by the head of Iraq's chemical weapons programme in 1983. However, there are indications that a BW research programme was always inherently in the MSE charter (perhaps lying dormant) of 1981. No immediate practical actions were taken until 1985, when a small biological group was formed at MSE (Figure VIII.IIA).

Late in 1985, bacterial strains, basic laboratory equipment, pilot-scale production equipment and materials were procured from foreign suppliers, and two agents were selected as candidate biological warfare agents. For its work the group used the existing infrastructure of the chemical complex, including several laboratories, an inhalation chamber and an animal house.

Lesson

In the initial phase of the re-started BW programme, the activities were located at a CW facility. This is one of the examples of a link between the Iraqi CW and BW programmes.

In the re-start of the BW programme it was under the control of Ministry of Defense and SOTI (State Organization for Technical Industries).

After the transfer to TRC it was under control of General Hussein Kamel, initially under the Special security apparatus and later under MIC.

Scaling up of BW programme activities, pilot-scale production (Step 2)

Despite the conventional wisdom that often links CW and BW as one larger programme, with the advancement of a BW programme the incompatibilities between CW and BW programmes are more pronounced. As with other countries which had CW and BW programmes, although in the early research and development stages the BW and CW groups may have some common needs and could share facilities, when the decision to move to bulk production occurs, BW and CW have been located separately to cater for their specific requirements. At this point, the programmes are segregated.

Iraq seemed to follow this pattern, and at the beginning of BW activities at MSE the biological group benefited from sharing some infrastructure with the CW task force. However, the biological R&D section seems to have been already segregated at the start, and later completely separated from the CW programme. In 1987 the CW programme personnel considered further expansion of biological activities at MSE to be incompatible with the other site activities and infrastructure. Consequently, the biological weapons

group was transferred to the Forensic Research Department of the Technical Research Centre at Salman Pak in mid-1987. General Al Sa'adi stated under an interview in 1998 (TEM Vienna, Section 3 "Sites") that this was a temporary location, until a purpose-built site was available.

The biological weapons programme was significantly expanded after its transfer to the Technical Research Centre. The pilot-scale SCP plant at Al Taji was acquired mid 1987, more laboratory equipment and materials were procured, and additional personnel were recruited. Construction was started on a new building at Salman Pak to house a pilot-scale fermenter. Production of botulinum toxin and anthrax began with the use of bench-top fermenters, and experimentation commenced using a range of animals to study inhalation and other exposure routes and effects. In 1988, Iraq began pilot-scale production of botulinum toxin at the then refurbished fermentation unit of the Al Taji facility.

Large-scale production (Step 3)

Early in 1989, the production of botulinum toxin was started at Al Hakam, while pilot-scale production of anthrax and aflatoxin began at Salman Pak. The production of anthrax at Al Hakam started later, in 1990. Research included laboratory-scale experiments related to the drying of anthrax. However, according to Iraq, since special dryers could not be obtained, this work did not progress.

To be able to reach the planned production levels of BW agents, large-scale fermentation equipment and specific spray dryers for Al Hakam were sought from foreign suppliers. In contacts with the foreign manufacturers cover stories were developed, both regarding the use of the equipment and its destination. These procurement attempts failed since prospective suppliers were not able to obtain export licenses from their national authorities. This severely hampered the efforts to produce BW agents, and ultimately led to the utilization of existing legitimate facilities for production as well as to attempts to manufacture the sought-after equipment indigenously.

Expansion of the programme (Step 3)

At the end of 1987, the scope of the biological weapons work was further expanded and research into additional bacterial agents, such as *Clostridium perfringens* and fungal toxins, such as trichothecene mycotoxins, was carried out. Later, in 1989, research on ricin toxin and *Clostridium botulinum* spores began within the biological weapons programme. In 1990, following the acquisition of the Foot-and-Mouth Disease vaccine plant at Al Dora, research on three viruses - camelpox, enterovirus 70 and human rotavirus - was initiated.

Infrastructure and technology know-how

In 1972, the Ba'athist government of Iraq nationalized the oil sector and major industries in Iraq owned by foreign companies. This gave revenues and assets required for

modernization and improvement of the technological base of Iraqi industries to make Iraq more self-reliant and less dependant on foreign countries.

Within a few years Iraq was providing social services that were unprecedented among Middle Eastern countries, and Iraq created one of the most modernized public health systems in the Middle East. To diversify the largely oil-based economy, the national infrastructure was improved including progress in building roads, promoting mining, and developing other industries. During the 1970s much of the oil profit was invested into industrial expansion.

This also included technical modernization of Iraq's Armed Forces. The newly established state planning committee, chaired by the Vice President of Iraq, coordinated and supervised all industrial developments, including the establishment of military industries.

To organize the construction of military industries, the Ministry of Industry of Iraq created the military industrial committee, which functioned as a co-ordination and advisory board rather than an administrative cell. In the early 1970's, in coordination with the Ministry of Defense, the committee, as a matter of priority, developed new military industrial complexes and revived those that had been formerly established. This became the foundation upon which Iraq's military industrialization was built.

The development of the military industrialization complexes included:

- two facilities for the production of small arms, the Yarmuk State Establishment in Abu Ghraib and the Qadissiyah State Establishment in Mahmudiyah,
- a production complex for manufacture of explosives, propellants and their ingredients and raw materials in Latifiyah known as the Al Qaa Qaa State Establishment, Iraq's largest military industrial complex, which was instrumental in supporting Iraq's chemical, nuclear and missile programmes
- a facility for testing and production of artillery ammunition and associated components, later known as the Hutteen State Establishment was constructed at Iskandariyah
- a construction company, Al Saad, later known as the Al Fao State Establishment was created in order to expedite the establishment of military industries in Iraq.

Between 1968 and 1972, Iraq's military industries were controlled by the State Organization for War Industries (SOWI) that was a part of the Ministry of Defense (MoD). In 1974, SOWI was reformed into the State Organization for Technical Industries (SOTI), later known as the Military Industrialization Commission (MIC). This organization took responsibility for all Iraq's research, development and production activities in the field of arms and military technology, while the Ministry of Industry and the Ministry of Heavy Industries were in charge of the civilian sector. SOTI later directed Iraq's biological, chemical and missile programmes.

"Silent Years", 1979-1985: biotechnology know-how and infrastructure build-up

During the period 1977-1983 a substantial effort was made to improve the biotechnology know-how and infrastructure in Iraq with a focus on large-scale production. Several facilities were built or equipped (Baby Milk Factory plant, the FMD Vaccine plant, the Al Taji SCP pilot plant, the Agricultural and Water Resources Centre, and the Veterinary Research Laboratory-Al Kindi), and later in different ways contributed to the BW programme. Moreover, during the 1980s several of the researchers later involved in the BW programme obtained scientific training abroad, many of them in the beginning of that decade.

There are no indications that this build-up of know-how and infrastructure in the biotechnology area was primarily done with the focus on a BW programme. After the nationalization of the foreign owned oil sector and major industries in Iraq in 1972, the government of Iraq had full access to oil revenues and assets required for modernization and improvement of the technological base of Iraqi industries. There was a philosophy to make Iraq more self-reliant and less dependant on foreign countries, and this included the construction of new modern enterprises using foreign know-how and contractors in exchange for its oil. Also, many other countries at this time made similar legitimate efforts.

Importance of legitimate facilities for production

After the invasion of Kuwait by Iraq in August 1990, the biological weapons programme increased the production of bulk biological warfare agents and began to weaponize them. Presumably because of the demand of higher amounts of bulk agents, and the difficulties in procuring production equipment, the Technical Research Centre acquired two commercial facilities.

The Foot-and-Mouth Disease vaccine plant at Al Dora was utilized for the production of botulinum toxin in 1990, and the production of vaccine was suspended. Several brick walls were erected to separate the zone established for biological weapons production from the area of the vaccine production. The Agricultural Research and Water Resources Centre (known as Al Fudaliyah) was used for the production of aflatoxin without any significant modifications to its infrastructure.

Lesson

During the 1970s and 1980s the biotechnology infrastructure was greatly improved in Iraq through the construction of several facilities (Al Taji SCP pilot plant, Baby Milk Factory, FMD vaccine plant, installation of a large-scale fermentation line at the Veterinary Research Laboratory- Al Kindi, and a date sugar processing pilot plant at Agricultural Research and Water Resources Centre). This presented an improved and essential platform as a base for the later Iraqi BW programme.

Based on their capabilities, civilian facilities were utilized in the Iraqi BW programme. Their contribution to the programme consisted of supply and storage of strains, supply of equipment and personnel, and pilot-scale and large-scale production. This stresses the importance of investigating all facilities with a dual-use capability.

Infrastructure and technology know-how are important elements of a BW programme. All capable facilities have to be investigated, since they may directly or indirectly be involved in a BW programme.

Delivery and weapons systems

Dissemination of agents and weaponization (Step 2, Step 3)

Early in 1988, Iraq began field trials on the dissemination of biological warfare agents. These trials involved munitions supplied by the Iraqi CW programme, and an aerosol spray device modified specifically for the BW programme.

After the defection of General Hussein Kamel in August 1995, Iraq declared that it had also weaponized bulk agent in 1990. The weapons included special warheads for Al Hussein missiles and R-400 aerial bombs, filled with liquid biological warfare agents. Iraq also provided information on other types of aerial and artillery munitions used in field trials with biological warfare agents or simulants.

Iraq has further declared two projects carried out in 1990 to investigate the modification of a MiG-21 fighter aircraft into an unmanned aerial vehicle and the conversion of a Mirage F-1 drop tank for the dissemination of biological warfare agents. Iraq also declared the development by the Technical Research Centre of smaller remotely piloted aerial vehicles in the late 1980s.

Lesson

For weaponization of BW agents, systems developed for the CW programme were utilized.

Iraq filled the weapons with liquid agent, but was interested in substituting this with dry agent. However, suitable equipment for drying was not available neither by import, due to export restrictions, nor by indigenous manufacturing, due to lack of know-how.

At the beginning of 1988, Iraq showed an early interest in aerosol dissemination. This continued in 1990 through two projects to investigate the modification of a fighter aircraft into an unmanned aerial vehicle, and the conversion of a drop tank for the dissemination of biological warfare agents.

Protective measures for the programme

Dedicated production facility

Following a successful although hurried research and development programme and basic pilot-scale production, the BW programme moved towards large-scale production that required the construction of a dedicated facility for this purpose.

Protection from exposure and attack

Iraq’s main BW agent production facility, Al Hakam, was built at a remote desert location in remarkably short time in 1988. It appears that Iraq, while developing Al Hakam, had drawn important lessons from its previous weapons projects, especially the

functioning of its chemical weapons complex MSE, which had been largely designed and constructed by foreign companies with the presence of their contractors on the ground. This resulted in the exposure of the true nature of that site and further led to the introduction of international trade regulations that impacted the chemical weapons programme.

In contrast, measures were taken to protect the BW programme from exposure. Al Hakam was built in full secrecy without the involvement of any foreign companies or contractors. Information regarding its physical location, purpose and affiliation to the Technical Research Centre was strictly classified. Even contracts for the acquisition of relevant equipment and materials for Al Hakam were issued under the cover of other Iraqi organizations and agencies. Moreover, equipment was transferred from other Iraqi facilities, making it possible to retain the secrecy of Al Hakam.

In contacts with the foreign manufacturers cover stories were developed, both regarding use of equipment and its destination, for attempts to procure large-scale fermentation equipment and specific spray dryers for Al Hakam after the decision to increase the production capacity for BW agents.

The facility also had features of physical protection like multiple air-defence units around its perimeter, enhanced protection and bunker-style structures, a distant separation of different areas within the facility, and a location in a remote area.

Lesson

A dedicated facility was built for the large-scale production of BW agents. This facility was probably supposed to be the key facility of the programme, integrating R&D and production activities.

The dedicated BW facility was built and equipped in total secrecy, without any direct involvement of foreign companies and contractors.

The security level for the dedicated facility was very high and included multiple air-defence units, enhanced protection and bunker-style structures, a distant separation of different areas within the facility, and isolation in a remote area.

Cover stories were developed for the facility and middlemen facilities, both for attempts to procure equipment and later to explain the nature of the facility for inspectors.

Deception and denial post 1991

After the Gulf War, the Al Hakam Factory had been devoted to production of SCP, biopesticides, and biofertilizers. Products under development included beer yeast, bakers yeast, starter cultures for yoghurt, and organic solvents. However, the production rates were at all times low.

The production effort involved equipment acquisitions through transfers' in-country or from Kuwait, as well as through the "Local Market", and attempts at manufacturing by

Iraqi facilities. Iraq had developed the expertise and technology to be fully capable of manufacturing essential production equipment, including a capability to specify, design, engineer details, instrument, manufacture, erect and commission spray driers of adequate quality for, for example, BW agents.

It is highly probable that manufacturing of SCP and biopesticides was developed in order to present a credible explanation for the Al Hakam Factory, and to disguise and hide evidence of the BW programme. By this it was possible to save Al Hakam with its buildings and equipment from destruction, and to maintain and develop production capability in form of technology and know-how for manufacturing products of potentially high civilian value. Alternatively, it could have been the expression of a wish for a future resumption of offensive activities.

Al Hakam was declared by Iraq in May 1991 as a site intended for the future production of "*vaccines or other materials produced by micro-organisms such as single cell protein*." This may indicate that they did not have the details of the cover story ready by that time. As the facility was not bombed during the war, the Iraqi side could have concluded that the coalition had little or no convincing intelligence information connecting Al Hakam to proscribed activities. Their decision to declare it anyway may have been prompted by the need to account for the manifold fermenters present that had been imported from Western suppliers.

Al Hakam was inspected for the first time end of September 1991. This left abundant time for decontamination, painting, plastering and reconfiguration. During this inspection, even though a broad range of indirect evidence suggested that Al Hakam might have been involved in a military BW programme, the Iraqi side provided convincing explanations for the manifold anomalies present. It was assessed that the very low containment measures present prevented the facility from being used for the production of pathogens, and 12 samples taken from equipment showed no proof of the existence of BW agents. Furthermore, no intelligence information suggested any role of Al Hakam in an offensive BW programme.

Lesson

Sanctions were effective in preventing Iraq from acquiring production equipment.

With the restrictions imposed on imports, Iraq developed an indigenous capability for manufacturing of essential dual-use equipment (thus circumventing the export controls). This highlights the necessity of inspecting manufacturing facilities, as well as biological production facilities.

Unveiling of Iraq's BW programme

From the beginning of its verification activities in Iraq, the United Nations undertook inspections to identify a variety of sites and facilities referred to it by member states as allegedly having been involved in the Iraqi biological weapons programme. Some of the sites were not declared by Iraq, and included facilities with possible underground structures. However, no facilities inspected on the basis of such information were found

to have been involved in the biological weapons programme. Al Hakam, the Foot-and-Mouth Disease vaccine plant and Al Fudaliyah were not among suspected sites referred to the inspectors through intelligence information.

The reasons for not uncovering Al Hakam Factory as a dedicated site for BW agent production, despite concerns regarding its true nature, is to a great extent attributable to resource constraints and time needed for building trust in the international community before valuable information from member countries on suppliers was coming forward:

Information from suppliers, especially on the growth media exports to Iraq, proved to be critical for Iraq's revelation of its BW production programme. Other information, such as on attempted purchases of fermenters and spray driers or conference attendance of personnel involved in the BW programme were also contributing to undermining Iraq's cover story.

Information from several independent sources:

- Defector information in 1991
- Al Hakam features and activities
- Intelligence
- Information from suppliers

Defection of General Hussein Kamel, and acknowledgement of the programme by Iraq

Iraq transferred formal ownership of the FMDV plant to TRC before starting BW work there. This included payment of all workers on site by TRC.

Lesson

If available, documentation on change in ownership of a facility may have indicated a change in production activities. This may not only include documents on site or elsewhere in the government/ administration, but also private documents of workers such as pay slips. These, however, are not easily accessible through site inspections.

The finding of direct evidence was furthermore difficult in the biological area since BW agent production is based on dual-use resources, and the relatively small quantities of seed cultures are easy to conceal. Due to the dual-use nature, indicators for the detection of illicit programmes are difficult to distinguish from those of permitted civilian activities. This is a particular problem at the early research stages of an offensive programme, but also in later stages some elements of the offensive activities can scarcely be distinguished from legal activities. As a result there is no single outstanding critical indicator for a state funded biological weapons programme, rather the aggregation of multiple indicators or specific "signatures" of indicators have to be used.

Indirect or secondary data actually provided a wide variety and significant amount of information about the Iraqi BW programme. Such data became available to the UN from different sources such as: (1) Iraqi declarations and statements, (2) interviews and discussions (3) documents, (4) on-site inspections and site monitoring, and (5) verification and monitoring of export-import transactions. The prolonged collection and analysis of indirect data revealed inconsistencies suggesting the existence of a BW programme. These inconsistencies were found in procurement information, and the material balance. Other factors that supported the assessment that Iraq had a BW programme were Iraq's inability to substantiate declared projects by supporting documentation, incomplete declarations, and dubious statements, and other signs identified and reported by UN inspectors.

Taking into account all lessons learned from the Iraq experience, it seems that the number of fingerprints of past proscribed activity have to be followed simultaneously and that there is a greater likelihood of uncovering aspects of such a programme through indirect evidence rather than direct evidence of finding bulk agent or biological weapons through an inspection process.

Thus, in summary, it was possible to gather enough information that cast serious doubt on the Iraqi cover stories, finally leading the Iraqi side to officially admit the role, for example, of Al Hakam in BW agent production. This, however, was all circumstantial evidence, which alone may not have been enough to make a 'firm' judgment in the sense that it would have convinced the Security Council.

On- site inspections

Although most staff involved in the production of BW agent at Dora came from Al Hakam, all staff at FMD must have been aware of changes, in terms of ownership of the site (payment of salaries) and in terms of production activities (new walls built in several areas of the site).

Lesson
It is extremely difficult to detect prior production of BW agents in a legitimate facility, if the BW production required only very limited modifications of the facility and if production took place only for a short period of time. In order to increase the chances of detecting such transient conversion of legitimate facilities, future inspection regimes should thoroughly investigate every facility capable of producing BW agents with no or minor modifications, even in the absence of any suspicions about a particular site.