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Engineer Intelligence in the NATO Combined Joint Task Force

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Abstract

Engineer intelligence is an important component of the Operational Planning Process at the NATO Combined Joint Task Force and the Land Component Command. It has evolved from the theatre-specific and land-centric Cold War scenario to a more comprehensive study of the effects of terrain on military operations and the effects of military operations on terrain. However, the engineer intelligence process has not kept up with the advances in information management technology resulting in engineer intelligence sections becoming overwhelmed by the demands for analysis and the amount of information available for analysis. In order to regain and maintain its relevance within the NATO CJTF, the engineer intelligence process must evolve to take full advantage of new information technologies, into a system capable of rapidly accessing relevant engineer information and providing timely detailed analysis to the engineer commander.

Within a NATO Combined Joint Task Force (CJTF) Headquarters, the Commander is provided with special staff to "handle special matters over which the commander wishes to exercise close personal conduct." One of these special staffs is the Joint Force Engineer (JF Engr), whose primary role is to act as the commander's principal advisor on Force-wide engineering matters and provide engineer input to the force planning process.[1] Furthermore, within the Land Component Command (LCC), the engineer commander will provide engineer advise to the LCC commander directly "on the correct mix of engineer support to formations or units as well as the engineer material to accomplish the mission."[2] Engineer commanders at the tactical levels provide similar advice to their commanders.[3] Engineers at all levels must coordinate their activities in order to streamline planning, accelerate preparation and maintain lines of communication.[4] This *technical net* is established to support the chain of command.

At each level of command, the engineer advisor is supported by his own headquarters staff, which includes an engineer intelligence capability. Within the CJTF, the JF Engr staff organization includes separate Geographic and Engineer Intelligence Staffs. The "Geographic Staff supports the HQ with geographic information and terrain analysis" while "the Engineer Intelligence Staff develops and maintains the engineer intelligence picture", which includes " all engineer assets, own and opposite, terrain information and the overall mine and unexploded ordnance situation." The engineer

[1]North Atlantic Treaty Organization, *NATO CJTF HQ Doctrine,* (January 1997)[Joint Doctrine on-line]; available from http://barker.cfc.dnd.ca/Admin/jointdocs/natopubs/cjtf_hq_doctrine/cjtftoc.html; Internet; accessed 26 March 2004, 3-4, 3-7.

[2]North Atlantic Treaty Organization, ATP-35(B) *Land Force Tactical Doctrine* (Brussels: NATO, 1995) 2-4, 2-23. (Note: While NATO doctrine refers to the senior engineer as the 'engineer commander', in practice he is referred to as the Chief Engineer, due to his staff rather than command function.)

[3]Department of National Defence, B-GL-361-001/FP-001 *Land Force Engineer Operations-Volume 1*, (Ottawa: DND Canada, 1998), 54, 57.

intelligence process is separate from the main intelligence process, yet is synchronized and linked with it offering an engineer technical analysis of data.[5] The same staff relationships and processes occur within the engineer staff at the LCC and those within the formations subordinate to the LCC.[6] Indeed the engineer intelligence process is an integral part of the Joint Intelligence Preparation of the Battlefield (JIPB) at the CJTF[7], and the Intelligence Preparations of the Battlefield (IPB) within the LCC[8], and, as such, it is an important component of the Operational Planning Process.

During the Cold War, engineer operations focused on a single theatre of operations with forces deployed from permanent bases. These operations were limited to pre-planned defensive operations making maximum use of pre-planned, prefabricated and pre-positioned material.[9] Thus, engineer intelligence concentrated on the effects of terrain and weather, and the ability of both friendly and enemy engineers to influence it. It has had a land-centric focus primarily interested in terrain analysis supporting the cross-country movement of large mechanized forces. The potential West German battlefield was well known, which simplified the terrain analysis. Indeed whole volumes of data were produced that provided pre-prepared terrain analyses for all parts of West Germany.

Since the end of the Cold War, NATO operations have become far more joint and expeditionary in nature, to regions where there is neither pre-planned capabilities nor the extensive host nation support found in the mature theatre of Europe. Furthermore,

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[4]North Atlantic Treaty Organization, AJP-3.12 *Joint Engineering* (Ratification Draft) (Brussels: NATO 2002), 3-3

[5]*Ibid*, 2-2.

[6]Department of National Defence, B-GL-361-001/FP-001 *Land Force Engineer Operations-Volume 1*, . . . , 91 – 93.

[7]North Atlantic Treaty Organization, AJP-3.12 *Joint Engineering*, . . . , 3-4.

[8]North Atlantic Treaty Organization, ATP-52(A) *Land Force Engineer Doctrine*, (Brussels: NATO, 1997), 4-5.

[9]North Atlantic Treaty Organization, AJP-3.12 *Joint Engineering*, . . . , 1-1.

infrastructure engineering, once confined to the rear area has become a theatre wide challenge. Engineers can no longer afford to focus on combat operations centred exclusively on land forces.[10] As a result, the demands and expectations of engineer operations have increased, and so too have the expectations for engineer intelligence. Recent advances in technology have increased the speed of collection and passage of information, as well as the means of collection. Thus, the amount of information available to be analyzed has grown beyond the capacity of the engineer intelligence staffs, who currently rely on e-mail and simple spreadsheets to transmit and analyze information. These processes are but an electronic version of the pen and paper methodology used before the advent of the personal computer. They are time consuming and limit the amount of information that can be analyzed. Consequently, the engineer intelligence staffs are becoming increasingly unable to provide the engineer commander with a complete engineer intelligence picture, which in turn impedes his ability to advise the CJTF commander. So, in order to regain and maintain its relevance within the NATO CJTF, the engineer intelligence process must evolve to take full advantage of new information technologies, into a system capable of rapidly accessing relevant engineer information and providing timely detailed analysis to the engineer commander.

This paper will examine the definition of engineer intelligence and the expectations the Commander and staff have from the process, with emphasis on the NATO CJTF. It will then examine the relationship between engineer intelligence and the Joint Intelligence Preparation of the Battlespace (JIPB), the Operational Planning Process (OPP) and the Joint Targeting Process. The current challenges to the collection and analysis of engineer information will be discussed, with particular emphasis on

[10] *Ibid,* 1-1.

infrastructure and the overall mine and unexploded ordnance (UXO) picture. The importance of engineer intelligence in the transition to post conflict operations will also be considered along with the involvement of government and non-government organizations. Finally, the use of emerging information technologies including geospatial information systems to leverage the intellectual strength of the engineer intelligence staff by automating a large portion of the collection of engineer information will be investigated, thus allowing much more time in analysis. The paper will conclude with a recommendation for a way ahead for the engineer intelligence process within NATO.

NATO defines engineer intelligence it as "that intelligence concerning enemy and friendly engineer operations and capabilities, the weather, military geographic information and resources information required for the planning of combat operations."[11] At the CJTF, engineer intelligence provides intelligence on: enemy engineer forces; country-specific information regarding the availability and acquisition of construction materials, services and water; the overall mine and UXO situation; information on infrastructure throughout the theatre; battle damage assessment; environmental impact; and geological information.[12] At the LCC, engineer intelligence also includes information on enemy obstacles, technical information about enemy engineer equipment, and meteorological data.[13]

The primary input of engineer intelligence into the OPP occurs in the description of the battlespace's effects in the JIPB process and the battlefield's effects in the IPB process through the provision of terrain analysis. NATO defines this process as "The collection, analysis, evaluation and interpretation of geographic information on the

[11]North Atlantic Treaty Organization, ATP-52(A) *Land Force Engineer Doctrine*, . . . , 4-5.
[12]North Atlantic Treaty Organization, AJP-3.12 *Joint Engineering*, . . . , 2-3, 3-5.

natural and man-made features of the terrain, combined with other relevant factors to predict the effect of the terrain on military operations".[14] In the JIPB process, terrain analysis is used to determine how the three-dimensional battlespace affects both friendly and adversary's potential courses of action, and provides a classification of terrain into no-go, slow go and go terrain, key terrain and avenues of approach.[15] At the LCC and tactical level, terrain analysis focuses on five key military aspects of terrain: observation and fields of fire; concealment and cover; obstacles; key terrain; and avenues of approach. The end product is usually a Modified Combined Obstacle Overlay (MCOO), which indicates cross country mobility, mobility corridors, obstacles, defensible terrain, engagement areas and key terrain. [16] This focuses on the ability of tactical formations to manoeuvre on the battlefield. At the tactical level, and indeed the LCC level it is a useful product for planning military operations as the terrain will be a major factor in determining the courses of action of both the enemy and friendly forces. At all levels, terrain analysis is a product of engineer intelligence that concentrates on the effect of geography on military operations. How then is the effect of military operations on geography dealt with?

There are both constructive and destructive geographic effects resulting from military operations. Within the operational theatre, military operations can have a negative effect on both the natural and man-made aspects of the terrain that will have an immediate adverse effect on subsequent military operations and that will last long after

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[13]North Atlantic Treaty Organization, ATP-52(A) *Land Force Engineer Doctrine*, . . . , 4-6.

[14]North Atlantic Treaty Organization, AAP-6 *NATO Glossary of Terms*, (Brussels, SHAPE, 2004), 2-T-4.

[15]Department of National Defence, B-GJ-005-200/FP-000 *Joint Intelligence Doctrine* (Ratification Draft), (Ottawa: DND, Canada, 2002) 1-4.

[16]Department of the Army, FM 34-130 *Intelligence Preparation of the Battlefield*, (Washington, US Army, 1994) 2-10. 2-22.

the end of hostilities.[17] At the CJTF level, the effect of military operations on geography is dealt with through the development of the overall mine/UXO picture, battle damage assessment and environmental impact.[18] It is in this particular area of the effect of military operations on geography that the current NATO engineer intelligence process is weak. This aspect of engineer intelligence is particularly vital for the engineer commander is his role as advisor to the CJTF, LCC or subordinate commander on issues of battlefield safety, infrastructure and the transition to post-conflict operations.

The engineer commander also uses engineer intelligence in his planning. Within formations subordinate to the LCC, engineer intelligence staffs will complete a separate engineer IPB. This separate IPB is done because the IPB prepared by the corps or division will not completely satisfy the needs of engineers. It focuses on terrain, weather, infrastructure and engineer resources, economics, and treaties and legal restrictions. The objective is to provide the Engineer staff with additional data for evaluating enemy and friendly engineer courses of action, namely enhancing the mobility and survivability of the friendly forces and the denial of the same to the enemy. [19] It is not intended to duplicate the effort of the G2 staff, but rather to compliment the IPB by contributing to the overall process and supplement it by providing additional analysis. At the operational level the engineer intelligence process is also closely integrated with the JIPB process. Although the process in the operational level engineer intelligence staffs is similar to that at the tactical level, there is no doctrinal reference to a separate engineer JIPB.[20]

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[17]Patrick Michael O'Sullivan, *The Geography of War in the Post Cold War World*, (The Edwin Mellen Press: New York, 1989), 167, 171.

[18]North Atlantic Treaty Organization, AJP-3.12 *Joint Engineering*, . . . , 2-3, 3-5.

[19]Department of National Defence, B-GL-361-001/FP-001 *Land Force Engineer Operations*, . . . , 80-83.

[20]North Atlantic Treaty Organization, AJP-3.12 *Joint Engineering*, . . . , 2-3

Nevertheless, there is a continual requirement for exchange of information between engineer intelligence staffs at all level using the engineer technical net.

Both terrain analysis and Engineer IPB focus almost entirely on combat operations. There is little consideration of post conflict operations, even though engineers play a major role in both the transition to and during post conflict operations. Such consideration is left to the JF Engr, who will be planning for post conflict operations before combat has even commenced. Furthermore, his advice to the Commander will be tempered with the knowledge that plans for reconstruction will be key to the transition to peace. Thus, he will want to limit damage to civilian infrastructure wherever possible and be prepared to provide the most comprehensive database possible on the effect of the military operations on the geography.[21] The CJTF engineer intelligence staff will need a solid link with subordinate engineer intelligence staffs in order to provide this database.

The volume of information that must be gathered and analyzed to support planning for post operation cleanup and reconstruction is significant. The challenge of handling the vast quantity of engineer information has been recognized within NATO through various internal discussion papers. The most recent internal paper suggests that the engineer intelligence staff will be overwhelmed by the amount of information coming in by means of modern communications technology.[22] Furthermore, recent exercises have validated this concern, noting that information related to post conflict operations was gathered continuously. It was here that the shortcomings of the Engineer Intelligence Process at NATO became apparent. There was a massive amount of information to be gathered, but no protocol in place to facilitate the collection process. The main

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[21]North Atlantic Treaty Organization, AJP-3.12 *Joint Engineering*, . . . , 4-7.

information challenges were in civilian infrastructure, targeting, Battle Damage Assessment, and Battlefield Safety. The main process challenges were the lack of any information management system in place to handle the large quantity of information. [23]

Civilian infrastructure is the first challenge. Information on infrastructure is required for three reasons: it is required to be used by the CJTF in operations and in some cases denied to the adversary; certain infrastructure must be protected under the Law of Armed Conflict; and damaged or destroyed infrastructure must be rebuilt after the end of hostilities. Infrastructure information is gathered in conjunction with the J2, J4 and legal branches. However, the JF Engr requires much more information than locations, capacities and potential status under the Law of Armed Conflict. An engineer analysis of infrastructure to be used by the CJTF will focus on the need to provide support-engineering assets to the repair and maintenance of infrastructure or even the construction of infrastructure where a needed capability is absent. This will include: surface and underwater mine and UXO clearance; infrastructure at Air Points of Disembarkation (APODs), Sea Points of Disembarkation (SPODs) and Railheads; accommodation and routes, bridges and forward operating bases.[24] This analysis will also include utilities infrastructure such as distributions systems for electricity, water, natural gas, and steam, sewers, and oil pipelines. Many of these will be underground, so will not be obvious to

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[22]Major D. M. Kennedy, "Engineer Intelligence in NATO," (Service Paper, Joint Headquarters Centre, Heidelberg, 14 December 2001), 9.

[23]North Atlantic Treaty Organization, *Final Exercise Report Exercise Cannon Cloud 2002*, (Heidelberg, JHQ Cent, 2003), ES-8, 9. The NATO Joint Force Center in Heidelberg conducted Exercise Cannon Cloud in late 2002, which was a High Intensity Warfighting exercise for preparation and training of NATO headquarters and forces in Multi-Corps/CAOC combined and joint military operations. The aim was to plan and conduct a campaign and major operations at the operational level in a Combined/Joint collective defence scenario. Within the LCC Headquarters, the Engineer Branch was manned by both core staff and augmentees and included an Engineer Intelligence Section.

[24]North Atlantic Treaty Organization, AJP-3.12 *Joint Engineering*, . . . , 4-8.

the J2 staff and will require an engineering knowledge of infrastructure to determine likely locations and routes of these systems.

The JF Engr will use information regarding infrastructure to provide advice in the in the Target Development, Validation, Nomination, and Prioritization Phase (Phase 2) of the Joint Targeting process in his capacity as one of the commander's special staff branches.[25] This advice is required to focus the collection effort to identify choke points and limit the destruction of infrastructure, especially that with potential value to subsequent operations, including post-conflict operations. This advice will include advice on the best method of attack, enemy responses to attack including deception and the consequences of an attack in terms of time and cost to replace damaged or destroyed infrastructure.[26]

The JF Engr will also provide targeting advice in cooperation with the legal branch to provide advice regarding infrastructure protected under the Law of Armed Conflict (LOAC). [27] Such infrastructure, which must be protected, includes civilian hospitals, cultural objects and places of worship that constitute the cultural or spiritual heritage of a people.[28] Dams, dykes and nuclear power plants must not be attacked, even if they are deemed to be legitimate military targets, if the attack will result in the release

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[25]United States, Joint Chiefs of Staff, JP 3-60, *Joint Doctrine for Targeting*, (Washington, Joint Staff, 2002), III-6, 7.

[26]North Atlantic Treaty Organization, AJP-3.12 *Joint Engineering*, . . . , 4-7.

[27]Office of the Judge Advocate General, "1949 Geneva Convention IV, Art 18," In *Collection of Documents on the Law of Armed Conflict,* 2001 ed., ed. Directorate of Law Training (Ottawa: DND, 2001), 111.

[28]Office of the Judge Advocate General, "1954 Hague Convention for the Protection of Cultural Property, Chap 1, Art 1," In *Collection of Documents on the Law of Armed Conflict,* 2001 ed., ed. Directorate of Law Training (Ottawa: DND, 2001), 134.

of dangerous forces and consequent sever losses among the civilian population.[29] Water purification installations and distribution systems are deemed indispensable to the civilian population and as such are protected but with some limitations.[30] Finally, The natural environment must be protected against widespread, long-term and severe damage resulting from armed conflict.[31] All of these issues have a requirement to be assessed by the JF Engr staff in cooperation with other key staff in the HQ. While the actual locating of the facilities is a J2 function, anything involving utilities, the environment, structural integrity and physical protection are within the JF Engr staff area of expertise. Of particular concern is the destruction of modern bridges within built-up areas. Bridges not only carry road or rail traffic, they also carry water, sewage, natural gas, steam, electricity, and communications lines.[32] The destruction of a bridge near a hospital may inadvertently cut its water and power supply, its source of heat and the communications system for emergency services, or its destruction may cut off clean water to a large segment of the population.

The JF Engr will also wish to limit collateral damage and the cost of reconstruction. For example, during the Kosovo air campaign, several bridges were destroyed on the Danube River, which not only cut off road communications within Belgrade, it severed international trade along the Rhine-Main-Danube Waterway, which

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[29]Office of the Judge Advocate General, "1977 Geneva Additional Protocol II, Art 15," In *Collection of Documents on the Law of Armed Conflict,* 2001 ed., ed. Directorate of Law Training (Ottawa: DND, 2001), 179.

[30]Office of the Judge Advocate General, "1977 Geneva Additional Protocol I, Art 54," In *Collection of Documents on the Law of Armed Conflict,* 2001 ed., ed. Directorate of Law Training (Ottawa: DND, 2001), 161.

[31]*Ibid*, Art 35, 158.

[32]New Jersey Department of Transport, "Utilities," *Design Manual for Bridges and Structures*[on-line]; available from http//www.state.nj.us/eng/ documents/BDMM/pdf/bmsec34.pdf, Internet; accessed 04 April 2004. Note: This reference provides a sample of design specifications for the incorporation of utilities

stopped commerce amounting to $100M per annum, which affected civilians in Germany, Austria, Croatia as well as Serbia. The subsequent cost of repairing the bridges was estimated at $100M.[33] This cost represented only a fraction of the total damage to infrastructure in Serbia. The situation in Iraq is much worse, although some damage dates back to the first Gulf War. Nevertheless the total is in the tens of billions of dollars. Thus, the JF Engr, and the engineer commanders at the LCC and tactical levels are key advisors in the targeting process at all levels, and require detailed engineer intelligence analysis to provide this advice in cooperation with other advisors.[34] The end result is the identification of certain targets on the no-strike list (NSL).[35] The amount of information that the JF Engr will need regarding infrastructure in a theatre of operations is significant and will vary with the size of the operation and the effected area. He must advise the operational commander on the pros and cons of targeting infrastructure and why some should be protected, even some that are not protected by the LOAC. He must also be prepared to assist Government Agencies and NGOs with reconstruction by providing as much data as possible on the state of the infrastructure in the affected countries.

The JF Engr is also involved in the Combat Assessment Phase (Phase 6) of the Joint Targeting Process. One of the components of this phase is battle damage assessment (BDA), which determines the outcomes of an attack, estimates the consequences and determines the effect on the adversary's behaviour. This requires a detailed familiarity

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into bridge design. It is not a definitive reference as each government will have similar but distinct specifications.

[33]Anthony H. Cordesman, *The Lessons and Non-Lessons of the Air and Missile Campaign in Kosovo*, (Washington, D.C.: Center for Strategic and International Studies, September 1999), 73.

[34]North Atlantic Treaty Organization, AJP-3.12 *Joint Engineering*, . . . , 1-5.

[35]United States, Joint Chiefs of Staff, JP 3-60, *Joint Doctrine for Targeting*, . . . , GL-8.

with all aspects of the analysis.[36] In the case of assessing BDA to infrastructure, that familiarity is vested in the JF Engr intelligence staff.[37] Their involvement also allows for the preparation and maintenance of a comprehensive infrastructure damage picture throughout the conflict and in preparation for the post-conflict phase. Depending on the amount of urban terrain in the theatre of operations and the amount of targeting, the amount of information will be significant.

Engineers are also involved in the BDA process to assist in the development of the overall UXO picture through the accurate tracking of hazards resulting from attacks.[38] For every air sortie, rocket or tube artillery attack against a ground target, either fixed or mobile, there will be a risk of unexploded ordnance (UXO). This will result from both the malfunction of the ordnance delivered to the target and from the disruption of ammunition within the target. Data regarding the potential malfunction of ordnance is one of the functions of munitions effects analysis (MEA), another output of the Combat Assessment Phase.[39] Disruption occurs when Armoured Fighting Vehicles or transport vehicles carrying munitions are attacked. In the case of the 1999 NATO air campaign, a total of 10,484 strike sorties were flown which dropped a total of 6,303 tons of munitions, consisting of 23,000 bombs and missiles.[40] Of the bombs dropped, 1,392 were cluster bombs dropped within the province of Kosovo against 333 separate strike sites. These contained 289,536 bomblets of which about 10%, nearly 30,000 bomblets failed to

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[36]*Ibid*, II-8-10.
[37]North Atlantic Treaty Organization, AJP-3.12 *Joint Engineering*, . . . , 3-5.
[38]*Ibid,* 3-5.
[39]United States, Joint Chiefs of Staff, JP 3-60, *Joint Doctrine for Targeting*, . . . , II-9.
[40]W.J. Fenwick, Targeting and Proportionality during the NATO Bombing Campaign against Yugoslavia, *The European*

detonate.[41] The number of airstrikes in this case indicates the sheer volume of information that must be collated and evaluated in order to provide the complete UXO picture. It took almost a year to provide detailed information on air strikes to the UN Mine Action Coordination Center because there was no process in place to collate the data.[42] These weapons are as dangerous on the ground as anti personnel landmines, yet there is no legal obligation to mark or record them. However, there is both an operational requirement and a moral obligation to reduce the risk to friendly forces and to civilians.[43]

The JF Engr intelligence section develops the overall mine/UXO picture through the collation and analysis of BDA summaries. To this is added the details on all minefields laid by friendly forces as well as enemy minefields encountered by friendly forces. All available information on enemy strikes, be they from air, rocket or tube artillery or mortars will be added to the picture. Such information is available from shelling reports (SHELLREPs), mortar reports (MORTREPs) and bombing reports (BOMBREPs). While these are not likely to be entirely accurate or all inclusive, it is valuable information that can be processed into a useful product that will clearly identify the areas of high risk and help to save lives.

The expanded requirements for infrastructure data input into the targeting process and the overall mine and UXO picture have significantly increased the amount of

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[41]International Committee of the Red Cross, *Cluster Bombs and Landmines in Kosovo*, [on-line]; available from http://www.icrc.org/Web/eng/siteeng0.nsf/htmlall/5RBH7C/$File/ICRC_002_0780.pdf ; Internet; accessed 31 March 2004.

[42]Carlotta Gall, U.N. Aide in Kosovo Faults NATO on Unexploded Bombs, *The New York Times* (23 May 2000) [Journal-on-line]; available from http://www.commondreams.org/headlines/052300-01.htm; Internet; accessed 31 March 2004.

[43]Office of the Judge Advocate General, "1996 Prl

information that the JF Engr and LCC engineer commander's intelligence staffs must now handle. Within the staffs themselves, there are two main challenges. The first is that during peacetime, there is only a skeleton staff at any of the NATO headquarters, which must be augmented by temporary staff brought in from the NATO member nations. This includes the engineer intelligence staff. These augmentees, of which there may be insufficient numbers, may not have the necessary skills or experience to fill the positions they are tasked to without additional training.[44] Thus, the process for collecting the large amounts of information should be automated as much as possible to reduce the amount of time required for training of augmentees and to allow for the maximum amount of time for analysis.

The second challenge is that the volume of information cannot be handled with the existing information technology within the engineer intelligence section. Information is currently handled using simple spreadsheets and word processors, which are no more than an electronic version of the pen and paper methodology of old. New software is required to leverage the intellectual power within the Engineer Branch in the limited time available during operations. Since the bulk of the information being processed is terrain related, a possible solution to this problem is the use of a Geographic Information System (GIS). A GIS is defined as a "computer-based system for capture, storage, retrieval, analysis and display of spatial or locationally-defined data."[45] GIS are already in use by

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minefields are not required to be marked on the ground. However, they must be recorded for future clearance.

[44]Joint Headquarters Center, *Final Exercise Report Exercise Cannon Cloud 2002*, . . . , 3-20-1.

[45]United States Army Corps of Engineers, *Geographic Information Systems*, [on-line]; available from http://www.nww.usace.army.mil/gis/definition.htm; Internet; accessed 26 April 2004. Note: GIS are not the sole property of geomatics units, such as the Mapping and Charting Establishment. While they may use GIS in the performance of their duties such as terrain analysis, other staff branches can use GIS to equal effect.

militaries, government and industry worldwide as tools to assist in terrain analysis, planning and situational awareness.

NATO is already planning to field such a system at the strategic level to be integrated into the master communications and information system. It will include a *data warehouse* managed at the strategic level to include geospatial data of all types including digital maps, weather data, and terrain information. However, the key staff at the operational level headquarters, such as operations, intelligence, logistics and engineers should also have a functional area sub-system (FASS), which will rely on the NATO GIS to provide information, assemble it and analyze it in accordance with queries submitted.[46] An Engineer Functional Area Sub-System (ENGFASS) would provide the JF Engr and the Engineer Intelligence Section with the automated collection and analysis capability to meet the expanded requirements for Engineer Intelligence within the NATO CJTF. However, it is important to understand how GIS works in order to understand the benefit to the CJTF. This can be done by looking at an example of GIS and applying it the engineer intelligence information management challenge.

An example of a GIS for military use is a commercial-off-the-shelf software designed to meet the needs of the United States Department of Defence. This software package, called the Commercial Joint Mapping Tool Kit (C/JMTK), is a "standardized, commercial, comprehensive toolkit of software components for the management, analysis, and visualization of map and map-related information."[47] C/JMTK is a

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[46]Major D. M. Kennedy, "Engineer Intelligence in NATO," . . . , 11.

[47]US Army Engineer Research and Development Center, *Commercial Joint Mapping Toolkit*, available from http://www.erdc.usace.army.mil/pls/erdcpub/www_welcome.navigation_page?tmp_next_page=6140; Internet; accessed 15 January 2004.

Windows based software system that utilizes digital mapping to meet a wide variety of data management and analysis requirements. It consists of four software modules. The first is the Spatial Data Base Module that can import, manage, query, retrieve and export data or data sets. The second is the Analysis Module that contains a number of terrain analysis algorithms that are applied to the data or data sets retrieved from the Spatial Data Base Module. The third is a Visualization Module that can produce standard products such as map overlays that can be viewed electronically, or in hard copy. Finally the Utilities Module is capable of doing automatic conversions from Latitude and Longitude to Grid References as well as other conversions such as units of measure.[48] This latter capability is important because air and maritime forces tend to use latitude and longitude while land forces use Grid References. Such a system would automatically convert to the desired nomenclature. It can be linked to Command and Control Information Systems (C2IS), which would then provide much of the raw data required and be a recipient of the finished products. This is not intended to be a product used solely by terrain analysts. It is one that can be used by any staff function to rapidly collect analyze and graphically display information related to the battlespace. How then could this assist the JF Engr and his engineer intelligence section?

An example of how the CMJTK might work to assist the CJTF engineer intelligence section is in the development and maintenance of the mine/UXO picture. Raw data from BDA reports, SHELLREPS, BOMBREPS and so on, would be collected electronically by the Spatial Data Base Module from the NATO C2IS. The Analysis Module would then process the raw data. This module would contain a series of algorithms (based on MEA data) that would determine the probability of UXO based

[48] *Ibid.*

upon the type of munitions, terrain conditions and the target attacked. The Visualization Module would then produce an electronic overlay for use with a digital map of the UXO threat at the location of the attack. During the process, the utilities module would ensure that data is presented in consistent units of measure, such as converting latitude and longitude into Military Grid References. The end product would be the electronic overlay that could be produced as a hard copy map or an overlay that could be handed to NGOs and other agencies during the post-conflict phase. GIS could also be used to produce similar overlays for infrastructure, utilities, transportation systems and so on. However, it is important to note that the quality, accuracy and completeness of the end product will depend on the accuracy and completeness of inputs from all layers of the command structure. Thus, there is a requirement for compatibility between GIS and Command and Control Information Systems (C2IS) of the NATO member nations.

In the case of GIS, in order to ensure standardization, it is not necessary to use the same manufacturer's product throughout. There are a large number of software manufacturers specializing in GIS software and those that produce software capable of handling GIS data in different formats, integrate it into a single environment for use in a standard format in the Data Warehouse.[49] This capability will be of further benefit during the post-conflict phase when it will be necessary to transfer unclassified databases and geographic information to GOs and NGOs for UXO and mine clearance, and infrastructure rehabilitation. Many NGOs already use GIS technology, which will simplify the transfer of data. An example is the European Union sponsored commission into damage assessment in Kosovo, which has set up the Kosovo Integrated Information

[49]Intergraph Mapping and Geospatial Solutions, *GeoMedia*, Available from: http://imgs.intergraph.com/geomendia , accesses 14 March 2004.

System, which uses a commercially available GIS to track UXO, mines and damage to infrastructure in the theatre.[50] However, there will be a need to standardize the criteria for data collection.

NATO has established a series of protocols and procedures to support electronic messaging and the electronic handling of data to facilitate interoperability among member states.[51] These procedures and protocols set generic standards for messages that would be directed to any NATO database or sub-system including an ENGFASS spatial database. The CC2IS of some NATO member nations are already capable of such interoperability. In the case of Canada the Land Force Command and Control Information System (LFC2IS) is based on the Athene Tactical system, which is capable of storing and manipulating a large quantity of operational information. It already includes an engineer functional area sub-system and a GIS capability,[52] and it is a planned that LFC2IS will be interoperable with the NATO system by 2009.[53] Thus, once the interoperability has been established, a Canadian formation using LFC2IS in a NATO led theatre could provide input into a NATO ENGFASS at the operational level. Clearly, Air and maritime C2IS systems would also have significant input onto the same process.

In summary, engineer intelligence at the NATO operational level has grown well beyond the land-centric, European focus of the Cold War. It supports the JF Engr and engineer commanders in their decision-making and advisory capacities, as well as the

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[50]European Commission Damage Assessment Kosovo, International Management Group, *The Kosovo Integrated Information System*, available from http://www.img.ba/kosovo/main/kiis; Internet; accessed 15 March 2004.

[51]North Atlantic Treaty Organization, ACP-123 *Common Messaging Strategy and Procedures*, (Brussels: NATO, 1997), 1-1, 1-2.

[52]Department of National Defence, *LFC2IS System Overview* [CD-ROM]. (Ottawa: NDHQ/DLCSPM 4, 2004), 2, 4, 5.

JIPB and IPB process. It consists of much more than terrain analysis or the effect of geography on military operations. It includes a considerable amount of analysis of the effect of military operations on geography. With the move to out-of-area operations and a greater emphasis on post-conflict operations, the volume of information to be collected and analyzed has grown beyond the capacity of the existing information technology within the NATO JF Engr and LCC Engineer Intelligence branches.

Information regarding the state of infrastructure at the outset of hostilities, including the location and interrelationship of protected sites, utility systems and infrastructure required by the coalition later in the campaign is critical to the JF Engr's ability to advise the commander, and significant in volume. Furthermore, the developing situation regarding UXO and mines is of utmost importance to ensuring the safety of NATO forces moving within the combat zone as well as the safety of civilians returning to their homes post-conflict. That information coupled with the summary of data regarding damaged or destroyed infrastructure is crucial to GOs and NGOs involved in the post-conflict restoration of the battlefield. This is a massive amount of information that must be quickly collected, analyzed and disseminated to those needing it.

It is proposed that an Engineer Functional Area Sub-System (ENGFASS) be established as part of the NATO master communications information system to meet the new increased information management demands of engineer intelligence at the JFHQ. ENGFASS should be based on commercially available GIS software and hardware and should be linked to the LCC and tactical levels through national C2IS established under NATO interoperability standards. This will give the JF Engr intelligence branch the

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[53]LCol J.L. Chevalier. *C4ISR 'Way Ahead' Workshop—Director Land Command & Information*

capacity to manage the expanded infrastructure and UXO data demands in future conflicts.

Engineer Intelligence is a mixture of science and art. The analysis of engineer information into engineer intelligence involves a great deal of scientific fact, results from scientific process as well as a military artist's understanding of the terrain. Thus, it requires both the intellect of an engineer and the vision of a commander. Engineer Intelligence is not a lost art; it has just lagged behind the advances in technology. NATO's latest forays into out of area operations in the Balkans and Afghanistan will serve to raise the profile of this requirement, which must be re-equipped with 21st century technology supporting it.

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