# Negotiating the Dayton Peace Accords through Digital Maps[1]

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## Background

From 1991 to 1995, the former country of Yugoslavia was wracked by fighting between the Bosnian Serb, Croat, and Muslim ethnic factions that took over 300,000 lives. The period was marked by a number of unsuccessful "peacekeeping" and negotiating initiatives. International frustration peaked in July, 1995 with revelations in the press about ethnic cleansing in Muslim enclaves that had been overrun by the Serbs, prompting the United States to launch an all-out negotiating effort to bring an end to the fighting.

Former Ambassador Richard Holbrooke led the U.S. negotiating team that worked with and through the United Nations Contact Group for Bosnia-Herzegovina to eventually bring representatives of the warring factions to Wright-Patterson Air Force Base at Dayton, Ohio. The road to Dayton was complex, and involved a mix of aggressive and creative diplomacy as well as demonstrated willingness by the U.S. and NATO to use military force.

Intense negotiations were conducted at Dayton from 1 to 21 November 1995, resulting in an initialing ceremony for a peace accord that was formalized in Paris in mid-December. These negotiations were called "proximity peace talks" because they were conducted in the same fashion as the shuttle diplomacy that first brought the warring factions to the table. Because significant territorial issues had to be resolved at Dayton, maps were a significant part of the currency of negotiation.

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Digital technology had matured enough by late 1995 that Dayton marked the first significant appearance of "digital maps" in diplomatic negotiations. "Digital mapping" and "digital maps" are broad terms used loosely in this paper to include automated cartography, computer-assisted map tailoring, spatial statistical analysis, and terrain visualization. This paper recounts and analyzes the role of digital maps in the Dayton peace accords, and draws out lessons from the Dayton experience that may be instructive to both the diplomatic and mapping communities.

A number of organizations provided mapping support for the negotiations leading up to Dayton, for the formal Proximity Peace Talks, and for operations subsequent to the peace accord. Ambassador Holbrooke's initial diplomatic shuttles were supported by a few people working primarily with paper maps and manual measuring devices. During September, 1995 the U.S. Army Topographic Engineering Center (TEC) contributed several teams of analysts equipped with portable computer systems that could perform simple area computations and compose and print maps in limited quantities; these teams accompanied Ambassador Holbrooke and his team on several of their shuttle missions. The deployment of a mapping support team to Dayton started small but grew tremendously in scope, eventually involving 55 people and over $4 million worth of mission equipment. The Defense Mapping Agency (DMA, now a component of the National Imagery and Mapping Agency, NIMA), contributed senior leadership (including the agency Director, Major General Philip Nuber), production management personnel, library and map distribution personnel,

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and a variety of production equipment with operators. The U.S. Army, through TEC and the 30$^{th}$ Engineer Battalion, contributed technical and managerial personnel as well as digitizing stations, map composition workstations, and hardcopy output devices. DMA's and the Army's assets were augmented at Dayton by contractors from Cambridge Research Associates (developers of the PowerScene (tm) terrain visualization system), Camber Corporation, and 3-M Corporation (developers of the Remote Replication System). Subsequent mapping support for implementation of the peace accords came from DMA (now NIMA) and from both U.S.-based and forward-deployed topographic assets of the military services.

Major equipment items used at Dayton for digital mapping support included two PowerScene(tm) terrain visualization systems, one of which was rigged for large-screen projection, three Sun workstations equipped with ARC/INFO(tm) geographic information systems (GIS), four Digital Topographic Support System &endash; Multispectral Image Processor (DTSS-MSIP) workstations equipped with ERDAS Imagine(tm) software, ten Hewlett-Packard (HP) 650C plotters, a Remote Replication System (RRS), three Canon Bubblejet(tm) A-1 copiers, one large-format Canon Bubblejet(tm) 2436 copier, and two more Canon Bubblejet(tm) copiers made available off-base for surge replication.

The technological environment for digital mapping at Dayton, although cutting edge at the time, was clearly one of transition, with many unrealized possibilities. The systems brought to Dayton had been designed for other uses, complicating integration and production flow. The negotiators being supported were used to paper maps, the crisp appearance of printed detail, and the flexibility of drawing on their map copy where and when they wished. Their demands for what they perceived as "quality" of product and familiarity of support inhibited the pace of weaning to better, faster, and more flexible support possible with the provided digital technology. Despite these inhibitors, digital mapping became a core tool, used wisely, that contributed significantly to the success of negotiations at Dayton.

## How digital mapping helped the Dayton peace talks

The mapping support strategy for Dayton was very straightforward and came directly from Ambassador Holbrooke and Lieutenant General Wesley Clark, the senior military member of the negotiating team. The strategy was: flood the negotiation site with U.S. military maps from DMA so there is no question about the authenticity, quality, or source of maps used as a foundation for discussions, keep modified maps and recomputations of territorial areas coming as fast as the negotiators need them, help make sure no contending side gains a marked territorial military advantage, and don't make any mistakes that might derail the talks.

Implementing that strategy involved a complex mix of traditional and digital mapping. Over 100,000 copies of printed DMA maps were shipped to Dayton and augmented by the modest on-site production of nearly 5,000 mapsheets; of these, 30,000 were actually distributed and used. Information from these maps (such as the outer boundary of Bosnia-Herzegovina) or from other sources such as battlefield maps from the front could be digitized and correlated to a common geometric foundation. Digitized map information (points, lines, and areas in vector form), names data, elevation data, scanned map images, and imagery could be pulled into the PowerScene(tm) terrain visualization systems and presented to negotiators as still screen shots, fly-through videos, or dynamic flythroughs under joystick control. The PowerScene(tm) system also supported dynamic annotation and visual assists such as flooding, slope computations, and intervisibility exploration. Any realignments of real or negotiated boundaries between the factions could be reflected in automated recomputations of areas and in adjustments of buffer zones. Further analyses, such as construction feasibility of the proposed corridor to the Muslim enclave of Gorazde, could be sent out to other supporting agencies and organizations. Any map changes made at Dayton could be printed out for use in further negotiation or could be transferred electronically to DMA for use in printing maps for implementation forces, minefield clearance operations, boundary marking, or other follow-on activities.

Map information used at Dayton included that on paper products (primarily the 1:600,000-scale UN Protection Force or UNPROFOR Road Map, 1:250,000-scale Joint Operations Graphic or JOG, and 1:50,000-scale topographic line map or TLM), raster-scanned variants of the JOG and TLM, Digital Terrain Elevation Data (DTED) Level 1 (which has an elevation post spacing of 3 arc-seconds or about 90 meters), 10-meter SPOT commercial imagery, and classified imagery from national systems.

The quality of map information used at Dayton was superb, although the master copy of the UNPROFOR Road Map, a favorite for the negotiators because it provided "one over the country" on a piece of paper that could be worked on by two people over a coffee table, was found to have a 1% stretch in one direction that confounded almost all fixes. Level of detail probably had the single biggest impact. Finding one's own house depicted on a tactical map at an air force base in a foreign country can be sobering, and knowing that anything on such a map can instantly become a target is even more unsettling. Seeing that same map indexed precisely in a three-dimensional terrain visualization system used for mission planning and rehearsal by combat aviators, along with imagery showing every rock and tree, ends all bravado. The first major contribution of digital mapping at Dayton, then, was putting a note of harsh reality, or intimidation, into the proceedings. In effect, the technology said: "We know about you; we've done damage before, and could do it again."

The second major contribution of digital mapping at Dayton was flattery. Some of the most advanced equipment of the time had been brought to Dayton, with a hand-picked team from Government and industry and commitments of back-up from DMA, the U.S. Army Corps of Engineers, and TEC, and was placed totally at the disposal of the negotiation effort around the clock, seven days a week, for however long the talks would take. In effect, this commitment of resources said: "This is the best equipment in the world, manned by the best team in the world; it is an instrument of war but we'll use it for peace because you are willing to come to the table."

A third major contribution of digital mapping, and something not possible with any manual processes, was assurance of absolute consistency. Once information was entered and registered to a common geometry, it could be propagated uniformly across all support systems, would not change without intervention, and would not be affected by subsequent viewing or use. Negotiators could be assured: "Once you draw a line, it will stay in its correct place across the full range of scales, portrayals, or uses such as PowerScene(tm) , maps, computations, subsequent boundary surveys, or field use with GPS navigation."

A fourth major contribution of digital mapping, and another not possible with analog procedures, was flexibility and responsiveness of support. The range of possibilities for support went from simple transcription of handwritten or drawn information from paper maps onto digitally-rendered map displays to interactive adjustment of negotiation lines in response to guidance from negotiators. Terrain visualization scenes responded directly to joystick input from operators or negotiators. Buffer zones could be adjusted nearly instantly when alignments changed, and terrain could then be inspected with the visualization systems to see how the changes affected military defensibility. Grades could be rapidly computed for proposed roadways. Operators could take a map with newly drawn lines from a negotiator, register and digitize the changes, and turn around very precise new computations about territorial percentages within about ten minutes. Six minutes after that, under ideal conditions, a fresh transparency for the revised map could be flowing from a printer. Under the best conditions (everything working and no competing tasks), within a total elapsed time of eighteen minutes from turning over the hand-drawn input, the negotiator could have new computations, a fresh map showing all changes, and assurance that the changes would appear consistently in all subsequent use. These capabilities said, in essence: "The support tools are so powerful, you can negotiate at your pace and not have to wait much for your revised maps."

The final major contribution of digital mapping at Dayton may have been more evident to the mappers than to the negotiators. Many activities in mapping are tedious and require diligence and attentiveness that are difficult to maintain through interruptions and changing guidance. Digital mapping delivered an incredible relief from drudgery. With it, operators could render the same objects at any scale. They could work with extremes of detail, knowing that whatever they did would be rendered faithfully in all subsequent work. They could insert buffer zones around curving, irregular negotiated lines with assurance of accuracy whatever the geometry. They could enter only local changes to negotiation lines and recompute instantly for the whole area of conflict, saving great effort. The message of digital mapping was, in effect: "However time-consuming and trivial your task might seem, we can probably set up something that can do the task endlessly, without complaint, with confidence that no gross blunders will occur because somebody got tired."

### Problems, disadvantages, and issues with digital mapping at Dayton

Digital mapping support at Dayton was marked by some unrealized expectations, some capabilities that were present but never adequately used, and some tantalizing possibilities for which technology was not yet ready.

The most visible technological disappointment had to do with fineness of detail, or resolution, in finished products. Negotiators were used to and liked printed map products. Presentation counted. A map with fuzzy or indistinct place names, or colors that varied across sheet seams, or other artifacts of raster scanning was clearly "inaccurate" or otherwise undesirable. ARC Digitized Raster Graphics (ADRG), DMA's standard raster-scanned map graphics, have a 100-micron sampling interval that works fine for displays on monitors but cannot match the sharpness of a printed map. Vectorized maps would have precluded such sharpness problems, but the Vector Map (VMap) product was not yet available for Bosnia-Herzegovina. The Canon Bubblejet(tm) , although capable of sufficient resolution and internally a digital device itself, had not yet been released with a much-needed external digital interface. The fundamental issue with resolution was that large-format rapid scanning and printing technologies in late 1995 were not fully up to the challenge of creating output comparable in resolution to that of offset lithography. The creative work-around found at Dayton involved holding all negotiated lines in vector form so that computations, manipulations, and printing of overlay information could benefit from digital technology; transparent overlays made on HP 650C printers were then registered to printed basemaps and the assembled products were finally copied on high-resolution Canon Bubblejet(tm) copiers. Although this procedure captured both the benefits of automation and the resolution of analog processes, it added time to the support cycle and introduced more potential sources of error, such as shifting of the overlays, that demanded more quality control checks.

Negotiators expected comprehensive version control of maps; they wanted to be able to retrieve or reconstruct things they had done previously, and needed to do this rapidly by referring only to a map's control number. Only elementary production control should have been required to index, retrieve, and reconstruct any support product, but this task assumed monumental proportions because things were kept digitally and files could be renamed and rearranged so easily. Storage capacity wasn't up to holding everything on line, particularly as negotiations progressed, and database cleanup and archiving operations by operators on different shifts frequently led to difficulty in locating and retrieving files. Ultimately, subterfuge prevailed. An extra master library hardcopy was made of every product delivered to the negotiators, no matter how urgent the support requirement, and this was simply further copied on a Canon Bubblejet(tm) when needed. Similarly, high-usage overlays were eventually hung in plain sight on walls in the production area to reduce hunt time on the computerized files.

Impatience reared its ugly head many times during support with digital systems. Negotiators were intimate enough with the support operations and anxious enough about their work that they frequently looked over the shoulder of operators. They could deal with how slowly electrons move when machines were printing their products, but seemed impervious to explanations about the computations involved in all other support operations such as file searches, map reformatting, tape backups, or database cleanups.

The mapping support team took more advanced capabilities to Dayton than the negotiators were ready or willing to use. For the most part, these capabilities would have required that negotiators change how they do their job; the constraints were more behavioral than technical. For instance, TEC imported a great deal of cultural and economic data, information on political boundaries internal to Bosnia-Herzegovina, and other thematic data considered relevant to the peace talks and suitable for analysis and display by geographic information systems. Negotiators, however, tended to focus on one thematic problem at a time and resolved the ethnic and political issues independently with their own information sources before turning to the supporting mappers later in the negotiations for thorny military defensibility issues. The systems taken to Dayton had significant capability for preparing image-based maps; perhaps because of unfamiliarity with these types of products, negotiators consistently requested that negotiation lines be superimposed on traditional symbolized maps and didn't want to hear alternatives. It was clear from the beginning that the pace of negotiations could be accelerated greatly by getting negotiators to point to things they wanted moved on a computer screen, and then flashing the results to other parties for comment and counter-proposal. The technology to support this was available, but the process never got off the ground. Negotiators may have been intimidated by the technology, felt a loss of control and privacy by having to work with a computer operator not on their negotiating team, distrusted computers generally, or simply enjoyed the opportunities to consult at their own pace and deliver their proposals at the most propitious times. As a case in point, when President Milosevic of the Serb Republic was engaged directly by the U.S. team on the night of 16 November over the access corridor to Gorazde, negotiations started on the PowerScene(tm) terrain visualization system and ended with felt-tip pens on acetate over maps. The only simultaneous use of the PowerScene(tm) system in projection mode in the Command Center of the Air Force Materiel Command at Dayton by representatives of the contending parties occurred in a marathon adjustment session of the negotiated lines <u>after</u> the agreement was initialed on 21 November and the principals had departed.

### Important lessons from this case for future diplomacy

There should be an iron-clad rule that mapping support for negotiations come from a single source, preferably one perceived as unbiased. This was achieved at Dayton, and permitted the establishment of a common series of products for discussion and a common geometric framework. Very early in the mapping support at Dayton, when it became obvious that there would be an obsession about the 51-49 percent territorial split, the team digitized the outer boundary of Bosnia-Herzegovina from the most detailed source available and used the complex stored polygon as the foundation for all subsequent computations. This sort of control, which is crucial to repeatability of results and confidence in the support processes, would not have been possible with multiple supporting activities, each approaching tasks differently and arguing about the outcomes.

New technology often requires new behavior and will be met with resistance unless it is clearly superior to the old ways. Sometimes this resistance can be overcome by brute force, as was done at Dayton. The support team of 55 people was able to mount a continuous operation with two overlapping 13-hour shifts that could stay ahead of negotiators who were often one deep and could not sustain much more than 18-hour work days. The technology was similarly brute-forced. The combination of visualization flythroughs, transfer of decisions to paper maps and digitization back, and direct computation support on area percentages was forced together at Dayton, greatly aided the negotiations, and can now be considered a mature capability. The next wave of capability available for support of negotiations may include three-dimensional geographic information systems, true surficial and volume computations, higher-resolution geospatial information, internetted support capabilities for advanced analyses, and greatly improved printing devices. The target configuration should be for a client-server environment complete with a systems administrator to provide robust version control of files accessed by using workstations. Just as at Dayton, someone will have to make these systems work together and promote their value to the negotiations.

Support personnel need to understand the full capabilities and limitations of their technology, be close enough to the negotiating process to sense opportunities, and be empowered to jump in with potential solutions. Many modifications were made on the fly at Dayton to both the PowerScene(tm) and RRS by system operators from the developing firms; they saw needs, knew what to do, and took the initiative. In another case, a dispute between negotiators over miniscule territorial imbalances was put to rest by a computer operator who realized that the percentage in dispute lay within the territory covered by the width of the pencil line across the map of the country; he simply digitized to the other edge of the line and got the negotiations back on track.

No matter how advanced the technology, some workarounds will always be required to keep up with expectations. These workarounds will be a prime place for failure. There simply cannot be too much quality control. Diplomatic negotiations often hang by a thread and any mistake, however innocent, could be devastating.

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