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CRITICAL INFRASTRUCTURE PROTECTION PROGRAM

The 18th CI/KR Sector: Defining "Critical Manufacturing" by the Numbers

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On March 3, 2008, Homeland Security Secretary Michael Chertoff signed an internal action memorandum entitled *Identification and Establishment of the "Critical Manufacturing" Sector as a Critical Infrastructure/Key Resource (CI/KR) Sector.* With Secretary Chertoff's signature, the 18th CI/KR sector, Critical Manufacturing, was launched.

As a policy analyst who has viewed the proliferation of CI/KR sectors and the manner in which they have been defined over the last decade with some skepticism, I instinctively reacted to news that the 18th sector was soon to be born with emotions that were less than enthusiastic. Seventeen CI/KR sectors already had been designated using the six broad criteria found in Homeland Security Presidential Directive (HSPD) 7. Thus, many components and definitions of those sectors were broadly defined as well, leading to concerns that policymakers, in attempting to "protect everything" in an all-hazards context, in reality might protect nothing very well. Vague, imprecise definitions of the 17 sectors also has allowed the media to expose comical examples of "critical infrastructures" that detract from the seriousness of this policy initiative – one which does, after all, depend on a serious and committed public sector – private sector partnership.

The language used to define many of the CI/KR components and subcomponents within the 17 sectors has resulted in less obvious but significant technical problems that go to the heart of being able to precisely identify, measure and analyze the characteristics of each sector. This has bedeviled not just economists and policy analysts but those who are trying to establish meaningful and quality "metrics" under the National Infrastructure Protection Plan (NIPP) and the 17 – soon to be 18 – Sector Specific Plans (SSPs). Data availability, accuracy and quality are serious concerns in the development of so-called "NIPP metrics." Without good numbers, that which is truly critical cannot be identified, priorities cannot be set, and progress towards meeting goals established by HSPD-7, the NIPP and the SSPs cannot be measured.

In 2006, a multidisciplinary team of researchers at the CIP Program examined these issues and provided DHS officials with a memorandum of findings and recommendations. A derivative of the memorandum written by two members of larger team is published on the CIP Program website, *Considerations on the Use of Federal Statistical Data to Assess the Economics of DHS' 17 Critical Infrastructure Sectors* (Pommerening and Ebert, July 2006; http://cipp.gmu.edu/archive/Pommerening-EbertSectorCensus_0706.pdf).[1] Among the key findings and recommendation:

- *There is broad consensus on the lack of timely and accurate information on the extent and nature of critical infrastructures in the U.S., and the subsequent need for better data. Such data would help clarify assumptions about the true size and criticality of CI/KR. Not every single business establishment within any one of the 17 sectors is "critical" in and of itself.*
- *The federal government, state governments, local governments already collect enormous amounts of data and information from the private sector, including owner-operators of CI/KR. In particular, federal statistical agencies such as the Census Bureau, the Bureau of Economic Analysis (BEA) and the Bureau of Labor Statistics (BLS) collect and analyze information that could be used to inform and facilitate more refined economic studies and policy analyses of critical infrastructures and key resources.*
- *Established business and industry classification standards, such as the North American Industry Classification System (NAICS) and its corresponding KR metrics, the Standard Occupational Classification (SOC) system at BLS, allow for broad (*e.g., *3-digit NAICS) or increasingly granular (4+ digit NAICS) analyses, including employment and occupational demographics within NAICS categories.*
- *However, and with few exceptions, the existing 17 CI/KR sectors and their component parts apparently were created and defined with little if any consideration for the NAICS or other federal statistical conventions, and no methodology currently exists to align most of the 17 CI/KR sectors to the wealth of data that is available.*
- *One option is to align the CI/KR definitions far more closely with NAICS nomenclatures, which are widely employed in econometric analyses, including longitudinal ("time series") studies. For this, CI/KR sector experts –* i.e., *the Sector Coordinating Committees and the Sector Specific Agencies – and representatives from the federal statistical community would cross-tab their expert knowledge of their sector with the NAICS. All-sector protocols would be developed to eliminate or rationalize overlaps with other sectors.*

[1] The article is derived from a larger CIP Program study (unpublished) that was provided to the U.S. Department of Homeland Security in July 2006.

The background information above provides the setting for examining the new Manufacturing CI/KR sector. The *process* behind the creation of the 18th Sector and the *criteria* chosen to define it are the big story here, and DHS is to be commended for the rigorous analytical, statistics-driven approach used to justify the establishment of the Manufacturing CI/KR sector. The commendation is based upon a detailed understanding of the 5-page action memorandum signed by Secretary Chertoff on 3 March 2008 authorizing Sector 18, and a reading of a 19-page report, *Analysis of Manufacturing as a Critical Infrastructure Key Resource Sector*, dated October 2007, which both informed and traveled with the action memo. There are at least three reasons why the construction and definitions of the 18th Sector are noteworthy:

First, research and analysis grounded in the numbers *preceded* creation of the newest sector. This makes the 18th sector novel if not rational. At this time, the 18th Sector consists of nine manufacturing industries defined at NAICS 4-digit level of precision, as illustrated by the following table:

Exhibit 4. Potential Manufacturing Sub-Sectors with CI/KR Designation

Sector		Basis
Primary Metal Manufacturing		
3311	Iron and Steel Mills and Ferroalloy Manufacturing	Integral to multiple supply chains, limited alternatives, used in current CI/KR sectors
3313	Alumina and Aluminum Production and Processing	Integral to multiple supply chains, limited alternatives, used in CI/KR sectors
3314	Nonferrous Metal (except Aluminum) Production and Processing	Integral to multiple supply chains, limited alternatives, used in CI/KR sectors
Machinery Manufacturing		
3336	Engine, Turbine, and Power Transmission Equipment Manufacturing	Used in CI/KR sectors; long lead times
Electrical Equipment, Appliance, and Component Manufacturing		
3353	Electrical Equipment Manufacturing	Used in CI/KR sectors; long lead times
Transportation Equipment Manufacturing		
3361	Motor Vehicle Manufacturing	42 facilities with over 2500 employees generates direct and indirect economic output exceeding $10 billion/year
3364	Aerospace Product and Parts Manufacturing	35 facilities with over 2500 employees; (may be covered under Defense Industrial Base) generates economic output exceeding $10 billion/year
3365	Railroad Rolling Stock Manufacturing	Alternatives may not exist
3369	Other Transportation Equipment Manufacturing	May include specialty emergency vehicles – not sure

Source: *Analysis of Manufacturing as a Critical Infrastructure and Key Resources Sector*, Appendix A, Exhibit 4 (pp. 11 – 12).

For many of the existing 17 sectors, trying to find consistently accurate and defensible numbers to support rigorous economic and policy analyses came *after* the creation of the sectors. Like the CIP Program's July 2006 study, the October 2007 DHS report notes that many of the descriptions of what is included in the previous 17 CI/KR sectors are not grounded in the NAICS, which "is used by all U.S. government agencies for the collection, analysis and publication of statistical data."[2] Because of this, the October 2007 DHS report identifies six of the 17 sectors that ***may*** include manufacturing industries at a NAICS 3+ digit level.[3] The report also offers a remarkably honest observation: "DHS does not maintain a definitive list of which manufacturing sub-sectors are included in each of the 17 designated CI/KR sectors."[4] It is likely that DHS has not attempted to do compile the "definitive list" because lack of consistent definitions grounded in well-established classification systems would make the task difficult, time consuming – and the result probably imprecise. The new 18th sector has been defined, and thus can be measured and analyzed, with degrees of precision using publicly-available data from federal statistical agencies.[5] Federal data and statistics also can be augmented with other databases and sources of information to respond to highly specific analytical needs for which disaggregated statistical sources are inappropriate.

Second, Tier 1/Tier 2 "Criteria for Criticality" have been developed which serve as additional discriminators for framing the 18th sector. It should be noted that these criteria themselves are not risk-based. Apparently, these criteria are discriminators for determining which facilities within certain NAICS sub-sectors will be included in Sector 18 ("large facilities, large economic impact") and those that will not.[6] Tier 1 criteria include individual assets and systems that, if attacked, would produce at least two of the following four consequences:[7]

1. Fatalities > 5,000 persons
2. First year economic impact of at least $75 billion
3. Mass evacuations with prolonged absence of six or more months
4. Loss of governance or mission execution that disrupts multiple regions or CI sectors for more than one week resulting in loss of necessary services to the public.

[2] *Analysis of Manufacturing as a Critical Infrastructure and Key Resources Sector*. U.S. Department of Homeland Security, October 2007, page 4. The author notes that the report lacks the typical DHS branding and that an examination of the metadata found in the Adobe Acrobat PDF received by the CIP Program suggests that a Columbia, MD consulting firm, Energetics, may have actually produced most of the report.

[3] The six sectors are Defense Industrial Base; Food & Agriculture; Chemicals; Oil & Natural Gas; Commercial Facilities; and Public Health & Healthcare.

[4] *Analysis of Manufacturing as a Critical Infrastructure and Key Resources Sector*, p. 4

[5] In certain well-defined situations, academic researchers may have access to microdata within the confines of a Census research lab. Such access requires Census, and in some cases IRS, approval of a research proposal; fulfillment of a background check for all researchers; and strict compliance with established disclosure avoidance requirements for all research outputs proposed for use outside the lab.

[6] *Ibid.*, p. 9. Such discriminations – those focused on individual assets and facilities – will require additional analysis using establishment-level data. Existing authorities prevent DHS or its surrogates from obtaining establishment data from federal statistical agencies.

[7] *Ibid.*, p. 5. Emphasis is in the original report.

On first glance, Tier 2 criteria thresholds are somewhat more detailed than the first tier. There are four "macro" criteria in Tier 2 and an additional eight "sub-criteria," some of which are derived from criteria DHS has established in other CI/KR sectors:[8]

1. Potential for Mass Casualties
    a. Facility capacity greater than 10,000 persons
2. Impair Government Missions
    a. Assets requiring long lead times
    b. Sole source/specialized systems, subsystems components or parts
3. Potential Economic Impact
    a. Greater than $10 billion directly or *indirectly*[9] over one year
4. Cascading Impact on Other CI/KR Sectors
    a. Critical products for the electricity, oil & natural gas sector (*e.g.*, transformers)
    b. Critical products for nuclear facilities
    c. Critical IT products (*e.g.*, networking equipment or semiconductor manufacturing)
    d. Medically necessary products (*e.g.*, pharmaceuticals, therapeutic biologics, and medical devices).

DHS' analysis using *aggregated* Census data and based upon guidance found in HSPD-7 and Tier 1/Tier 2 criteria found that "nine manufacturing industries appear to meet one or more of the guidance criteria" for inclusion in the 18th sector.[10] It is not difficult to reach determinations of criticality for perhaps the first two criteria established by Tier 1/Tier 2 using federal statistical data (primarily Census). The last two criteria in either tier are more difficult to assess by the using available federal statistical data alone, in part because this would require "detailed economic analysis of supply chains and inter-sector dependencies."[11]

However, it is unclear from a reading of the October 2007 report the exact means employed to select the nine industries and their related sub-industries in higher-digit NAICS categories. The selection methodology is not transparent, particularly with regard to when Tier 1 criteria are chosen or (and?) Tier 2 criteria are applied. Further, while the report is explicit that at least two criteria from Tier 1 must be met, such explicitness is not offered for Tier 2, leaving the reader to question if more than one criterion is needed to satisfy the second tier. Four overall criteria are provided for each tier, but only two are somewhat comparable across the tiers, and the choice of different phrasing between seemingly related criteria in the two tiers may lead different interpretations. Oddly, while the number of fatalities/casualties/facility capacity is 5,000 and 10,000 for Tiers 1 and 2 respectively, the first year economic impact is $75 billion for Tier 1 but only $10 billion, *directly or indirectly*, for

[8] *Ibid.*, p. 6.
[9] Implies *interdependencies* with other CI/KR sectors.
[10] *Analysis of Manufacturing as a Critical Infrastructure and Key Resources Sector*, p. 9.
[11] *Ibid.*, p. 10.

Tier 2. The report is silent on whether Tier 1 economic impact is confined to *manufacturing* "assets and systems," or whether economic impacts to supply chains and cascading intra-sector and inter-sectors assets count – as they apparently do in Tier 2 by virtue of the word "indirectly."

The third distinguishing characteristic of the 18th Sector is that its nine manufacturing industries are completely aligned to the NAICS, and thus (as previously noted), this means the dimensions and economics of 18th sector can be measured and analyzed with a precision not readily available for the other 17 sectors. Oddly, the internal DHS action memorandum apparently does not mention this important development although the October 2007 report clearly and repeatedly states the need to define and organize sectors around the NAICS as key to conducting rigorous, quantitative research and analysis:

> *A definitive determination of whether these or other manufacturing industries meet the definition and conditions of a CI/KR sector may benefit from a detailed economic analysis of supply chains and inter-sector dependencies. However, such analysis may not be appropriate unless the same rigorous analysis is applied to the existing 17 CI/KR sectors. For consistent clarity, DHS, in consultation with each of the 17 Sector Coordinating Councils, may benefit from developing and maintaining a central list identifying the industries and sub-sectors included within each CI/KR sector using the standard NAICS nomenclature.*[12]

Four broad 3-digit NAICS categories of manufacturing are captured by the 18th CI/KR sector: (1) Primary Metal Manufacturing (NAICS 331); (2) Machinery Manufacturing (NAICS 333); (3) Electrical Equipment, Appliance & Component Manufacturing (NAICS 334); and (4) Transportation Equipment Manufacturing (NAICS 335). Within the four broad 3-digit NAICS categories, DHS narrows definitions for the 18th Sector to NAICS 4+ digit NAICS levels. It is these nine elements that constitute "critical manufacturing." For example, "Machinery Manufacturing" (NAICS 333) contains 28,306 individual manufacturing establishments (2002 Economic Census) employing 1,172,889 persons who generate annual shipments of $254.5 billion and annual payrolls of $49.8 billion. There are seven industries within NAICS 333 at the 4-digit NAICS level, as shown below:

Industry Detail	NAICS code	Description	Establishments	Value of shipments ($1,000)	Annual payroll ($1,000)	Paid employees
more	31-33	Manufacturing	350,828	3,916,136,712	576,170,541	14,699,536
	333	**Machinery mfg**	**28,306**	**252,476,407**	**49,838,051**	**1,172,889**
more	3331	Agriculture, construction, & mining machinery mfg	2,977	48,278,197	7,039,599	170,179
more	3332	Industrial machinery mfg	4,381	29,881,801	7,710,625	158,302
more	3333	Commercial & service industry machinery mfg	2,399	21,171,601	4,282,393	102,432
more	3334	Ventilation, heating, AC, & commercial refrigeration equip mfg	1,848	31,933,185	5,460,211	156,752
more	3335	Metalworking machinery mfg	9,162	25,442,220	8,403,530	191,746
more	3336	Engine, turbine, & power transmission equipment mfg	923	38,463,675	4,357,992	97,313
more	3339	Other general purpose machinery mfg	6,616	57,305,728	12,583,701	296,165

[12] *Ibid.* Emphasis added to the original.

In defining manufacturing that is "critical" within NAICS 333, DHS chose one of the seven 4-digit categories – NAICS 3336, Engine, turbine & power transmission equipment manufacturing. General statistics for NAICS 3336 are provided below:

Industry Detail	NAICS code	Description	Establishments	Value of shipments ($1,000)	Annual payroll ($1,000)	Paid employees
more	31-33	Manufacturing	350,828	3,916,136,712	576,170,541	14,699,536
more	333	Machinery mfg	28,306	252,476,407	49,838,051	1,172,889
more	3336	Engine, turbine, & power transmission equipment mfg	923	38,463,675	4,357,992	97,313
	33361	**Engine, turbine, & power transmission equipment mfg**	**923**	**38,463,675**	**4,357,992**	**97,313**
more	333611	Turbine & turbine generator set units mfg	112	14,966,426	1,004,848	19,486
more	333612	Speed changer, industrial high-speed drive, & gear mfg	241	2,036,388	547,444	13,237
more	333613	Mechanical power transmission equipment mfg	252	2,781,377	657,830	16,395
more	333618	Other engine equipment mfg	318	18,679,484	2,147,870	48,195

As readily can be seen, there are 923 manufacturing establishments in NAICS 3336 (33361), which represents quite a narrowing from the 28,306 establishments in "Machinery manufacturing." NAICS 33361 also can be analyzed at four separate 6-digit NAICS sub-industries.

What does this mean? What kinds of questions could be answered? Aggregated dimensions of the nine critical manufacturing industries could be measured in terms of revenues, shipments, payrolls and other elements captured by the Economic Census (EC) and the associated Business Register (BR) of over 9 million individual reporting units (commonly called "establishments"). as well as other Census industry surveys. Using GIS technologies and data from federal statistical establishments and other sources, the new 18th CI/KR sector can be "mapped" in any number of ways, including those that show interdependencies to other infrastructures. For example, establishments and their characteristics such as production levels, types of products, product toxicity, number of employees and payroll can be mapped against major transportation routes, water ways, hospitals, airports and populations (households).[13] Linking Census "business datasets" to Census "household datasets,"[14] a task routinely performed by Census researchers, allows Sector 18 industries and sub-industries to mapped to population characteristics of areas surrounding these critical infrastructures. Population characteristics can be resolved to the block or Census tract level of detail. This allows researchers to define "damage cells" anywhere in the Nation, and to model direct impacts as well as indirect impacts.[15] Census datasets also can be linked to other federal sources of data and information, such as those compiled by the Bureau of Labor Statistics (BLS), the Bureau of Economic Analysis (BEA) and others (such as FEMA GIS data and particularly FEMA remote-sensing GIS data).[16] For example, linking Census data to BLS data

[13] Note that the use of data elements such as production levels and toxicity would require creative use of imputation algorithms.
[14] Prime examples of household datasets are the decennial Census and the American Community Survey (ACS) products.
[15] While direct impacts are relatively easy to model, indirect impacts are more challenging and imprecise, such as modeling the threat cone of a chemical plant explosion under various and ever-changing conditions.
[16] Very shortly after natural disasters occur, such as the catastrophic hurricanes of 2005, FEMA provides detailed PDF maps and, of higher value to researchers ESRI ArcGIS shape files based on remote sensing observations and data.

reveals the characteristics and demographics of employment, such as the number (and specialization) of engineers, clerical workers and electricians within NAICS 33361.

Introducing geography opens up additional possibilities for analyzing the new Critical Manufacturing sector; some examples are mapping CI/KR *vis-à-vis* FEMA flood plain maps the potential effects of rising sea levels on CI/KR in coastal regions. Data from the nine 4+ digit critical manufacturing industries also could be used to develop metrics and benchmarks for some of Critical Manufacturing's Sector-Specific Plan. Locations of NAICS 33361 manufacturing can be extracted at the Census county, tract or block level.[17] One of the best examples of using various federal sources of data to analyze events and their impacts on business establishments and populations in a GIS context is *The Impact of Hurricanes Katrina, Rita and Wilma on Business Establishments*, published by Census Bureau economic researchers Ron Jarmin and Javier Miranda.[18] Jarmin and Miranda's work has inspired research activities and proposals at the CIP Program. With the authors' permission, we borrow liberally from their research (in the left-right indented paragraphs below) to illustrate analysis possibilities in mathematical form:

> [W]e employ a simple strategy that uses the share of geocoded businesses within a county or parish that lie in areas with a given FEMA damage classification to impute the total for the county. We can compute this since all establishments are geocoded to the county level and we know how many, within each county, we are able to give latitude and longitude coordinates. We multiply those shares by the number (or employment or payroll) of un-geocoded businesses. More precisely, for a given characteristic x (e.g., number of establishments, employees, payroll), the imputed total located within areas with FEMA damage classification d (d ϵ {undamaged, limited, moderate, extensive, catastrophic, flooded}) is given by
>
> $$x_c^d = \frac{x_{gc}^d}{x_{gc}} x_{\sim gc} + x_{gc}^d \quad (1)$$
>
> where c denotes the county, g denotes the total computed by summing across geocoded establishments, and $\sim g$ denotes the total computed by summing across ungeocoded establishments.

One can use this equation and merely change its variables to perform other analyses, such as for very specific NAICS categories in single or multiple CI/KR sectors for very small or very large

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FEMA maps show damage using six levels, from undamaged to catastrophic (level 5) and flooded/area under water (level 6).

[17] Subject to confidentiality, privacy and disclosure avoidance laws and regulations, including but not limited to Title 13 (Census), §§ 552 – 553 of Title 5 (loosely, the "Privacy Act"), the "e-Commerce Act," OMB regs, and the Homeland Security Act, notably §892(g) and Title II.

[18] 13 August 2007; http://www.ces.census.gov/docs/caed/papers/pap_157_Javier_Miranda.pdf

geographic footprints, or classifications other than FEMA's. Jarmin and Miranda have produced, and validated, two other equations that can be used "as is" or by substituting different variables:

5.1. A Model to Estimate Damage Using Post Storm Data

We have no direct way to assess the accuracy of the GIS damage classifications made available by FEMA. In the case of the impact on business establishments, it is possible, however, to use administrative data from the Census Bureau's business register to compare quarterly business payrolls before and after the hurricanes hit.[i] Our measurement strategy is to use a simple regression model to compare one-year growth in quarterly payroll across establishments located in affected and unaffected areas, and to compare affected establishments before and after the hurricanes. We use data for all the Gulf States and include FEMA damage classifications from hurricanes Katrina, Rita and Wilma. We specify the following regression model:

(2) $$\gamma_{it} = X_i\beta + \varepsilon_{it}$$

where the dependent variable is the annual growth rate of quarterly payroll given by

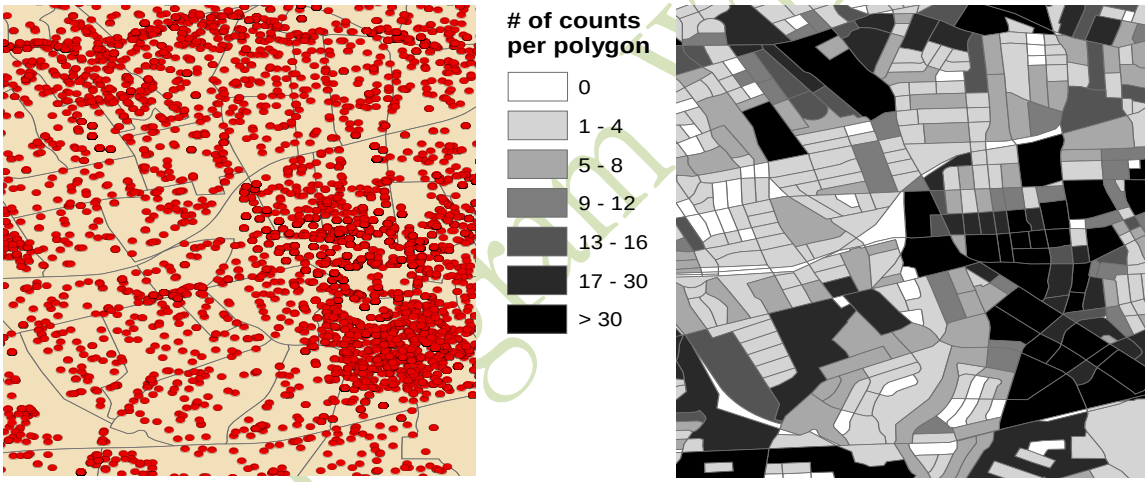
(3) $$\gamma_{it} = \frac{pay_{it} - pay_{it-4}}{.5*(pay_{it} + pay_{it-4})},$$

and X_i is a matrix of dummy variables indicating the class of damage sustained by establishment i from the hurricanes. The FEMA damage classifications refer to particular locations. So, in essence, the X variables are customized location dummies that are unique for each disaster event. The regressions compare the performance of establishments in locations with different FEMA damage designations. We use the nominal quarterly administrative payroll data in the BR to measure pay_{it} as the payroll for establishment i in quarter t. In addition, we run the regressions for all quarters in 2005 so that we can compare the performance of establishments within a given FEMA damage classification before and after the hurricanes.

This is a good time to discuss one of the most important limitations of using data which the federal government has collected "for statistical purposes only." It is a requirement of law that businesses (and households) respond to surveys received from federal agencies such as the Census Bureau. However, data availability and accuracy – the quality and coverage of statistical information

– depends not on a punitive legal threat but a government promise of confidentiality to survey respondents that the information they provide will not be disclosed in any manner that would allow individual persons to be identified. The promise of confidentiality is important because the entire statistical establishment depends upon voluntary compliance, and robust voluntary compliance is the only path to accurate numbers. Consider, for a moment, how data and information released daily by the statistical agencies and institutional consumers of federal statistics affects business planning, government policies, global markets, and individual economic behavior. The promise of confidentiality is too important to compromise it, even for the context of CI/KR modeling.

Census and other federal statistical agencies have disclosure rules that do not permit data to be released for a given industry sector and/or geographic boundary that pinpoints, directly or by inference, individual identity. One simple disclosure test is whether there are three or more entities within any given classification breakout for any given geographic boundary. However, there are many techniques that can be used to turn pinpoints of critical infrastructure establishments into visual data that is very useful for planning purposes at the national, regional, and state levels as the images below illustrate:



The image on the left shows individual business establishments in a NAICS sector in a fictional square state. Establishment level data behind these points on a map cannot be disclosed, nor can individual establishment locations on a map, which also may reveal identity. However, the image on the right uses a GIS technique ("blurring") to create polygons that show various concentrations of those same establishments within given tracts of geography, most of which can provide aggregated data and information which can be disclosed. Such mapping is particularly useful in high-level planning, geographically illustrating CI/KR concentrations and potential chokepoints, etc. Researchers at the CIP Program intend to expand on the 2006 research into attempting to align

selected CI/KR sector definitions to NAICS categories through a GIS-based project conducted at the Census Bureau's laboratory in Suitland, Maryland.

In conclusion, it is encouraging DHS chose to tightly align the new 18th CI/KR sector with the North American Industry Classification System. It allows critical infrastructure planners and analysts to better understand the impacts and consequences of vulnerabilities to elements within a sector. Statistical data can be used to construct the right-hand side of the classic risk equation, $R = \int (C, T, V)$. Aligning CI/CR sectors to familiar statistical classification regimes such as the NAICS provides the ability to perform sophisticated analyses almost instantly. The use of NAICS-based statistical data allowed DHS to analyze all manufacturing sectors, narrowly define what is critical, and provide a policy justification for establishing the new 18th sector. Together with Tier 1/Tier 2 discriminators, DHS has defined "critical manufacturing" with *measurable* precision that has been illusive for many of the existing 17 CI/KR sectors. Re-working the other 17 sectors into a homogenized, NAICS-based regime will allow more precise and rational determinations of criticality in addition to facilitating and visualizing supply chain and cross-sector interdependencies.

The author wishes to acknowledge and honor his mentor and friend, Dr. Edward M. "Monty" Graham (1943 – 2007), Senior Fellow at the Peterson Institute for International Economics. In my second year as a young congressional staff member, I sought out Monty after reading Graham – Krugman's landmark 1988 work on foreign direct investment in the United States. Within that book were the seeds for legislation that my boss, Rep. Philip R. Sharp, along with Reps. Lee H. Hamilton and Nancy L. Johnson, would introduce and see enacted into law in 1990. One of the policy assumptions in Graham – Krugman was that our very divisive and politicized debate about foreign direct investment (FDI) was the result of incomplete or missing information about how FDI was impacting the U.S. economy – especially employment. Graham – Krugman suggested the information gap could be fixed by allowing establishment- and industry-level data sharing between Census and the Bureau of Economic Analysis (BEA). The 1990 legislation ultimately authorized three-way data sharing among Census, BEA and the Bureau of Labor Statistics (BLS), with annual analytical reports to the Congress based upon that data. That experience began my exposure at a serious level to the federal statistical agencies and the very important work they perform. Monty continued to be a mentoring force in my life. We worked on other legislative proposals and wrote a journal article together, and we also became friends who shared a common passion for bicycling. In late 2004, I called Monty in search of expert advice on data availability for an offshoring study. Once again, Monty offered assistance and opened a few new doors. It was then that I became aware that Monty had inoperable colon cancer that had spread to vital organs. But our reunion was filled with Monty's incredible optimism, discussions of new medical technologies, and hope tempered with appreciation for the wonderful life he had lived so far. He passed away last year. So, Monty, thank you for all your contributions to international economics, public policy, good legislation . . . and good numbers.

[i] Jarmin and Miranda: Again, we would prefer to use a metric like sales, but it is not available on a quarterly basis.