



ANGLE Technology

The Economic Impact of Modeling, Simulation and Visualization in Hampton Roads (Virginia)

Update

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The following economic impact report was prepared by ANGLE Technology LLC for the Virginia Modeling, Analysis and Simulation Center under contract with the Old Dominion University Research Foundation with economic impact modeling conducted by the Hampton Roads Planning District Commission. The data collection and analysis methods used by ANGLE Technology LLC for this study are those widely accepted as valid throughout the industry.

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We wish to thank all of the private companies and public sector organizations that participated in the survey.

The Economic Impact of Modeling, Simulation and Visualization in Hampton Roads Update

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1. Executive Summary

ANGLE Technology was asked by the Virginia Modeling, Analysis and Simulation Center (VMASC) to update the economic impact study conducted in 2004. The objective of the update was to track the development of the modeling, simulation and visualization (MS&V) industry in Hampton Roads over the past three years. The MS&V definition from the previous study was retained as shown in Appendix I.

The survey updated information on numerous issues in the industry as well as economic data on the number of direct employees and their average salaries. The economic data was used as inputs to an impact model developed by Regional Economic Models Inc. (REMI). The model used in 2004 (Version 5.5) was structured using Standard Industrial Classification (SIC) codes. Since then, REMI has restructured the model based on the North American Industrial Classification System (NAICS) and made additional improvements. However, this restructuring does not permit direct comparisons between 2004 and 2007 because the industry classifications do not match.

To address the comparison problem, REMI recommended running 2004 and 2007 data on their Version 8.0 as the best available option because it was designed with NAICS codes and is capable of representing the Hampton Roads economy for both time periods. Tables 1.1 and 1.2 present the results of this analysis.

Table 1.1 Economic Impacts, REMI Model Version 8.0 (constant 2000 dollars)

Factor	2004	2007	% Change
Output	258.4	364.6	41.1
Gross Regional Product	167.3	237.8	42.1
Employment	3,524	4,420	25.4
Average Annual Salary	\$60,212	\$82,733	37.4

Table 1.2 Forecasted Annual Job Growth Rate

PERIOD	2004	2007
Two Years	14.2%	7.3%
Five Years	12.3%	14.5%

- ◆ The MS&V industry continues to be an increasingly important sector in the regional economy, as measured by the 42.1 percent increase in its contribution to Gross Regional Product, the 41.1 percent increase in the industry's contribution to Total Output, and the 25.4 percent increase in Total Employment.
- ◆ There has been substantial growth in average salaries in the industry, increasing at an average of 12.5% per year and exceeding the average salary in Hampton Roads (\$38,428) by 133 percent
- ◆ The average annual job growth rate of 8.9 percent is significant, although less than the 14.2 percent forecasted in 2004
- ◆ Growth rate expectations over the next two years have been reduced, but higher rates are expected in the future

For reference, the 2007 data were also run on the same model used in 2004. The results are summarized in Table 1.3. As a consequence, the 2007 data does not reflect changes in the Hampton Roads regional economy since 2004.

Table 1.3 Economic Impacts, REMI Model Version 5.5

FACTOR	2004	2007	% Change
Total Output	\$412.9m	\$639.5m	54.9
Gross Regional Product	\$248.0m	\$408.1m	64.6
Employment	4,023	5,092	26.6
Average Annual Salary	\$60,212	\$82,733	37.4

Analysis of results of the 2007 data using both REMI versions 8.0 and 5.5 show significant growth in the modeling, simulation and visualization industry and demonstrate its importance to the regional economy.

2. Introduction

ANGLE Technology conducted an economic impact assessment of modeling, simulation and visualization (MS&V) activity in Hampton Roads in 2004 for the Old Dominion University Research Foundation under the sponsorship of the Hampton Roads Planning District Commission. In April 2007, the Foundation, through the Virginia Modeling, Analysis and Simulation Center, asked ANGLE to conduct an update of the 2004 study to assess the growth of the industry over the past three years. The economic impact analysis was again conducted by the Hampton Roads Planning District Commission using the economic impact model developed by Regional Economic Models, Inc. (REMI).

The following sections provide a comparison of the 2004 and 2007 results.

3. Survey Process

The survey process involved updating the list of respondents, conducting and following up the survey via email and telephone, and analyzing the results as described in the following sections.

3.1 Survey instrument

As this survey was an update of the 2004 survey, the original questionnaires were retained with some minor additions and reformatted for use by the Survey Monkey system.

3.2 Data Collection

The data collection process comprised several elements as follows:

1) Updating the respondent database

The original database, divided by public and private sectors, was supplemented with lists from the Hampton Roads Technology Council, the Hampton Roads Partnership, and VMASC. Respondents not involved in MS&V were removed and names, telephone numbers and email addresses were updated where possible. Multiple respondents in large organizations were consolidated to a single point of contact to avoid duplicate entries.

The final list of respondents is provided in Appendix IV.

2) Email distribution

Emails were sent to all potential respondents on May 1, 2007, explaining the survey and asking them to access the questionnaire via a link to the Survey Monkey system before May 31.

3) Follow-up with non-respondents

All potential respondents were contacted by both telephone and email. This task resulted in further reduction of the lists as contacts indicated that they were not involved in MS&V.

4) Closing the survey

The survey closing date was extended to allow additional follow-up work. Numerous telephone calls and emails were sent to non-respondents. The list of non-respondents is provided in Appendix IV. The survey was closed on July 26, 2007.

3.3 Data Analysis – Private Sector Respondents

Table 3.1 Final Survey Statistics in 2004

Group	Number of Organizations	Number of Responses	Percentage
Government	92	17	18.5%
Contractors	137	31	22.5%
Commercial	285	12	4.2%
TOTAL	514	60	11.7%

The list of public sector and private sector organizations that responded to the survey is provided in Appendix V.

Table 3.2 Response Data for 2007

Group	Number of Organizations	Number of Responses	Percentage
Public sector	23	14	61%
Private Sector	52	39	75%
TOTAL	75	53	71%

The much smaller number of organizations and the higher response rate reflects the elimination of organizations not involved in MS&V and the consolidation of multiple addresses for large organizations into a single point of contact.

The following sections summarize the survey results for each of the questions on the survey form.

3.3.1 Private Sector Respondent Profile

It is possible to characterize the typical MS&V organization based on the number of employees, annual sales, years in operation and industry sectors in which the organization operates. Forty-three private sector organizations responded to the survey in 2004. Of these, 34% had other business units operating in the Hampton Roads area, and 61% had other business units supporting MS&V outside of Hampton Roads.

In 2007, 39 private sector organizations responded to the survey. Of these, 38% had other business units operating in the Hampton Roads area, and 64% had other business units

supporting MS&V outside of Hampton Roads – not a significant change from 2004.

The overall private sector results are presented in the following tables.

Table 3.3 Number of Employees in Hampton Roads in 2004

No. of Employees	Percentage
1-10	12.2%
11-25	19.5%
26-100	21.9%
101-500	31.7%
501-1000	0.0%
1001-2000	2.4%
Over 2000	12.2%

In 2004, 53.6% of the private sector respondents had less than 100 employees and would be considered small to medium size enterprises (SMEs). Since the economic impact analysis considers only the number of MS&V-related employees, this question was revised in 2007 to focus on this sub-group rather than the total number. Table 3.4 indicates that 92% of the companies surveyed have fewer than 100 MS&V-related employees.

Table 3.4 Number of MS&V-Related Employees in Hampton Roads in 2007

No. of MS&V-Related Employees	Percentage
1-10	56%
11-25	21%
26-100	15%
101-500	8%
501-1000	0%
1001-2000	0%
Over 2000	0%

In 2004, 73.1% of the private sector respondents had less than \$50m in sales which classified them as SMEs, as shown in Table 3.5.

Table 3.5 Annual Sales for 2004

Current Annual Sales	Percentage
Less than \$1m	12.2%
\$1m-\$10m	34.1%
\$11m-\$50m	26.8%
\$51m-\$100m	2.4%
More than \$100m	24.4%

In 2007, the percentage of SMEs increased to 84% as shown in Table 3.6.

Table 3.6 Annual Sales for 2007

Current Annual Sales	Percentage
Less than \$1m	23%
\$1m-\$10m	38%
\$11m-\$50m	23%
\$51m-\$100m	3%
More than \$100m	13%

In 2004, 39.1% of the private sector respondents had been in operation less than 10 years in Hampton Roads as shown in Table 3.7.

Table 3.7 Number of years in operation in Hampton Roads for 2004

Years in Hampton Roads	Percentage
Less than 3 years	7.3%
3-5 years	12.2%
6-10 years	19.5%
More than 10 years	60.9%

In 2007, 43% have been in operation less than 10 years; 10% have been in operation less than 3 years as reflected in the entry of small companies in the market.

Table 3.8 Number of years in operation in Hampton Roads for 2007

Years in Hampton Roads	Percentage
Less than 3 yrs	10%
3-5 yrs	15%
6-10 yrs	18%
More than 10 yrs	56%

In 2004, the largest industry sectors were Aerospace and Defense (36 responses), although it should be noted that the number of responses for the ‘Other’ category was 15. Companies were allowed to select more than one category. This result is not surprising given the nature of business activity in the Hampton Roads region with the dominance of aerospace and defense government organizations including NASA, US Joint Forces Command, Langley Air Force Base, Naval Air Station-Oceana and others.

Table 3.9 Industry Sectors represented by the respondents for 2004

Industry Sector	Percentage
Aerospace	16.6%
Communications	11.1%
Defense	33.3%
Entertainment/Gaming	1.4%
Financial Services	4.2%
Manufacturing/Distribution	1.4%
Medical	4.2%
Other	20.8%
Port Operations	1.4%
Retail (Fast Food/Hotels)	1.4%
Ship Construction	2.8%
Tourism	0.0%
Transportation	1.4%
Urban Planning	0.0%

In 2007, the largest sectors were again Aerospace and Defense (46 responses) as shown in Table 3.10.

Table 3.10 Industry Sectors represented by the respondents for 2007

Industry Sector	Percentage
Aerospace	36%
Communications	33%
Defense	82%
Entertainment/Gaming	8%
Financial Services	0%
Manufacturing/Distribution	8%
Medical	10%
Port Operations	8%
Retail (Fast Food/Hotels)	0%
Ship Construction	10%
Tourism	0%
Transportation	15%
Urban Planning	3%
Building Construction	0%
Other	21%

In 2007, the following additional business sectors were reported.

Table 3.11 Additional Business Sectors Reported in 2007

Additional Business Sectors
Software & Hardware Development
Audio & Video Production/Marketing
Chem/Bio Defense
Emergency Management
Cyber Security, Information Technology
Atmospheric Sciences

The following emerging opportunities were also identified.

Table 3.12 Emerging Opportunities in 2007

Emerging Opportunities
Games for Education, Medical Modeling, Emergency Management
Global Cyberspace Integration Center, US Joint Forces Command
Transportation, Homeland Security
Open Architecture Development, CMM/CMMI Implementation, Lean Six-Sigma Implementation, Motion Modeling Development & Implementation
JFCOM experimentation
Unmanned Autonomous Vehicle Simulations, Biohazard Simulations
Transportation network models and simulation, natural disaster planning, Antiterrorist planning and execution, container traffic modeling, flood plan models and simulations, LEA models and simulations, Fire and EMS models and simulation, sanitation models and simulations (due to population increases)
Decision support in manufacturing and process related industries
Port operations and security, traffic control
Airborne Networking
Environmental Modeling, Intelligence Modeling, High Performance Computing, Game/Role-play modeling

3.3.2 MS&V Activity

The objective of this question is to better understand the different types of organizations involved in MS&V activities. The listed roles include end user, developer, service provider, support or other activity. Respondents were allowed to identify more than one role.

Table 3.13 MS&V Role for 2004

MS&V Roles	Percentage
End User	18.7%
Developer	28%
Service Provider	28%
Support	22.7%
Other	2.7%

Table 3.13 indicates an approximately equal distribution of activity across the different roles with an emphasis on the Developer and Service Provider roles in 2004. The 2007 results shown in Table 3.14 again indicate a reasonably uniform distribution with an emphasis on the Developer role and with more companies playing multiple roles.

Table 3.14 MS&V Roles for 2007

MS&V Roles	Percentage
End User	38%
Developer	64%
Service Provider	51%
Support	44%
Research	44%
Other	8%

3.3.3 MS&V Resources

Table 3.15 compares wages and employment between 2004 and 2007. It indicates that employment has been stable over the past three years, and average wages have increased by 25% over the three year period. Several respondents mentioned the reductions in the MS&V budgets of the US Joint Forces Command as the basis for reduced employment.

Table 3.15 Total Private Sector MS&V Wages and Employment (Unburdened)

Survey	Wages	Employment	Average Wages
2004	\$79,246,600	1,334	\$59,400
2007	\$79,830,000	1,073	\$74,400
Change	\$583,400	-261	\$15,000

3.3.4 Growth Forecasts

In 2004, private sector companies anticipated a two-year annual job growth rate of 18% followed by a five-year rate of 12%. In 2007, the outlook has been reduced to 8.5% in the near term followed by more rapid growth of 19.7% per year in five years as shown in Table 3.16

Table 3.16 Growth Forecasts

Forecast	2004	2007
2 Years	18%	8.5%
5 Years	12%	19.7%

3.3.5. MS&V Problems/Issues/Weaknesses

The following statements were included in the questionnaire to identify issues and problem areas.

Table 3.17 Private Sector Responses to the statement, “There is a lack of trained MS&V labor force in Hampton Roads” in 2004

Lack of trained MS&V Labor Force	Percentage
Strongly Agree	13.1%
Moderately Agree	36.8%
No Opinion	28.9%
Moderately Disagree	18.4%
Strongly Disagree	2.6%

In 2004, approximately 50% of private sector respondents moderately or strongly agreed that there was a lack of trained MS&V labor force in Hampton Roads. In 2007, it was increased to 60% as shown in Table 3.18.

Table 3.18 Private Sector Responses to the statement, “There is a lack of trained MS&V labor force in Hampton Roads” in 2007

Lack of trained MS&V Labor Force	Percentage
Strongly Agree	18%
Moderately Agree	44%
No Opinion	15%
Moderately Disagree	23%
Strongly Disagree	0%

In 2004, approximately 40% felt there was a lack of trained support staff. This percentage did not change significantly in 2007 with 44% concerned about the lack of support staff, as shown in the following tables.

Table 3.19 Private Sector responses to the statement, “There is a lack of trained support staff for MS&V in Hampton Roads” in 2004

Lack of trained support staff for MS&V	Percentage
Strongly Agree	5.3%
Moderately Agree	34.2%
No Opinion	26.3%
Moderately Disagree	31.6%
Strongly Disagree	2.6%

Table 3.20 Private Sector responses to the statement, “There is a lack of trained support staff for MS&V in Hampton Roads” in 2007

Lack of trained support staff	Percentage
Strongly Agree	8%
Moderately Agree	36%
No Opinion	28%
Moderately Disagree	28%
Strongly Disagree	0%

In 2004, approximately 24% felt there was a lack of infrastructure. This percentage increased significantly in 2007 with 45% concerned about the lack of infrastructure, as shown in the following tables.

Table 3.21 Private Sector Responses to the statement, “There is a lack of infrastructure in Hampton Roads to support MS&V” in 2004

Lack of Infrastructure	Percentage
Strongly Agree	5.3%
Moderately Agree	18.4%
No Opinion	36.8%
Moderately Disagree	39.5%
Strongly Disagree	0.0%

Table 3.22 Private Sector Responses to the statement, “There is a lack of infrastructure in Hampton Roads to support MS&V” in 2007

Lack of infrastructure	Percentage
Strongly Agree	13%
Moderately Agree	33%
No Opinion	18%
Moderately Disagree	33%
Strongly Disagree	3%

3.3.6 Gaps, Weaknesses or Needs

Respondents were asked to identify modeling and simulation gaps, weaknesses or needs that were applicable to their organizations. Table 3.23 indicates that in 2004 respondents were most concerned about certification and networking opportunities.

Table 3.23 Gaps, Weaknesses or Needs Identified by Private Sector Respondents in 2004

Gaps, Weaknesses or Needs	Percentage
Technology	13.8%
Standards	13.8%
Accreditation	13.8%
Certification	20.7%
Networking Opportunities	24.1%
Other	13.8%

In 2007, these concerns increased, and there was a significant increase in concerns about standards and other issues as shown in the following tables.

Table 3.24 Gaps, Weaknesses or Needs Identified by Private Sector Respondents in 2007

Gaps, Weaknesses or Needs	Percentage
Technology	13%
Standards	30%
Accreditation	17%
Certification	22%
Networking Opportunities	35%
Other	35%

Table 3.25 Other Issues Identified by Private Sector Respondents in 2007

Other Issues
Lack of technology interest groups
Funding
Funding and more acceptance of MS&V outside of DoD
Understanding the market
Contract opportunities
Lack of Direct Contracts for Small/Medium Businesses
DOD Funding Shortfalls

The respondents were also asked to “suggest solutions to address any of the gaps/weaknesses and/or problems identified above.” Their responses are shown in Table 3.26.

Table 3.26 Suggested Solutions to Gaps and Weaknesses Identified by Private Sector Respondents

Technology	Standards	Accreditation	Certification
Local professional certification training Post best solution practices	Create forums and seminars for local area attendees	Participate in area networking opportunities	Identify and contact resources for assistance
Host after-hour events with specific technology topics to be addressed	Host technology interest groups	Develop categories for M&S with relative standards for accreditation	
Obtain resources to provide assistance	MS&V standards need to be developed by the community-an important step is achieving status as a profession	An organization like VMASC is in a position to become an accreditation body	
Teach people what they achieve/save/understand/sell with M&S, not just how to do it	Obtain resources to provide assistance	Certification of the workforce is a criterion for accreditation	
Legislative priority to push funding	Increased funding for standards		
There is a tremendous opportunity in M&S and a powerful mix of government, academia and industry here. Sell it.	Implementing something like ISO standards would be a good start		
More integration with Hampton Roads Technology Council events			
Create a joint M&S plan			
Provide venues outside of DoD			
Increased funding for research			
More revenue so we can afford better talent			

The respondents were also asked to “comment on any other pertinent information we should be aware of for this survey.” These comments are listed in Table 3.27.

Table 3.27 Other Pertinent Information Identified by Private Sector Respondents

<p>A consortium approach with leading edge technologies is needed to pioneer the way ahead. Too much emphasis is on contractor supported events and not enough on technology to empower users to run events on demand.</p>
<p>I am aware of only a few partnerships, large and small business, supporting DoD. I would like to identify more potential partnerships that can help reach into the commercial sector. There are a lot of technologically capable resources in the area, most needing only to get together to share potential. Hampton Roads could become the heart of advanced technology for the future!</p>
<p>I think M&S in Hampton Roads is going to grow tremendously in the near future. It's a great planning/training tool, but I don't think business and industry know how to apply it to their respective challenges yet. I think the future marketing of M&S needs to show different industry sectors. Once that happens, I think M&S in the region will grow tremendously.</p>
<p>This is a growth industry BUT it must be approached on a regional level. The DoD engine that has supported the industry's growth over the past ten years is not likely to continue to sustain growth; rather, we must look for growth to be supported by export of the M& S capability into other customer bases.</p>
<p>DOD funding for M&S has been in decline for the past several years</p>
<p>Most of this region's M&S business is focused on DoD because they are the ones with money for contracts. That won't change until companies are willing to spend \$'s to use M&S and to outsource their M&S requirements.</p>

3.4 Public Sector Respondent Profile

Public sector respondents were asked to characterize their organizations by number of employees, annual sales, years in operation and industry sectors in which the organization operates. The private sector results are presented in the following tables.

In 2004, 17 public sector organizations responded to the survey. Forty-one percent had other business units operating within Hampton Roads, and 35% had other business units supporting MS&V outside the region.. Approximately 65% of the public sector respondents had less than 500 employees as shown in Table 3.28.

Table 3.28 Number of Employees in Hampton Roads in 2004

No. of Employees	Percentage
1-10	5.9%
11-25	11.7%
26-100	5.9%
101-500	41.1%
501-1000	5.9%
1001-2000	17.6%
Over 2000	11.8%

In 2007, approximately 93% had fewer than 500 employees, as shown in Table 3.29.

Table 3.29 Number of Employees in Hampton Roads in 2007

No. of Employees	Percentage
1-10	50.0%
11-25	21.4%
26-100	21.4%
101-500	0.0%
501-1000	7.1%
1001-2000	0.0%
Over 2000	0.0%

In 2004, more than 75% of the public sector respondents had been in operation over 10 years in Hampton Roads.

Table 3.30 Number of years in operation in Hampton Roads in 2004

Years in Hampton Roads	Percentage
Less than 3 years	5.9%
3-5 years	0.0%
6-10 years	17.6%
More than 10 years	76.5%

In 2007, all of the public sector organizations that responded to the survey have been in Hampton Roads over ten years.

3.4.1 MS&V Activity

The following questions are intended to provide insight into the focus of the organization's MS&V activities. Respondents were allowed to identify more than one focus.

Table 3.31 MS&V Focus in 2004

MS&V Focus	Percentage
Analysis	37%
Training	28.5%
Experimentation	34.3%

In 2004, these results indicated a relative balance across the three areas. In 2007, additional categories were included as shown in Table 3.32. The Analysis, Training and Experimentation activities all showed significant increases from 2004, and the new categories of Education and Engineering also showed significant activity.

Table 3.32 MS&V Focus in 2007

MS&V Focus	Percentage
Analysis	57.1%
Training	42.9%
Experimentation	50.0%
Acquisition	7.1%
Education	42.9%
Engineering	28.6%
Other (please Specify)	28.6%

The Other category included the following activities.

Table 3.33 Other Categories Specified by Respondents

Other
Research
Economic Development
Operational Evaluation

In 2004, over half of the public sector organizations were end users and developers (Table 3.34). The high percentage of Developers was attributed to the participation of Old Dominion University (ODU) in the public sector survey.

Table 3.34 MS&V Roles in 2004

MS&V Roles	Percentage
End User	36.1%
Developer	27.8%
Service Provider	16.7%
Support	19.5%
Other	0.0%

In 2007, 64% of the public sector organizations were either end users or developers, and there were small reductions in service provider and support functions. A new Research category showed significant activity that can be attributed to the participation of ODU in the public sector survey.

Table 3.35 MS& V Roles in 2007

MS&V Role in Hampton Roads	Percentage
End User	42.9%
Developer	21.4%
Service Provider	14.3%
Support	14.3%
Research	42.9%
Other	28.6%

3.4.2: MS&V Resources

Table 3.36 compares public sector wages and employment between 2004 and 2007. It shows a substantial increase in employment that can be attributed partially to the participation of additional organizations in the survey. Employment reported in 2007 was significantly higher than reported in 2004, and average wages increased by 47% over the three year period.

Table 3.36 Total Public Sector MS&V Wages and Employment

Survey	Annual Wages	Employment	Average Annual Wage
2004	\$19,830,880	325	\$61,018
2007	\$91,520,250	1,058	\$89,726
Increase	\$71,689,370	638	\$28,704

3.4.3 Growth Forecasts

In 2004, public sector organizations anticipated a two-year annual growth rate of 13% followed by a five-year growth rate of 7%. In 2007, the outlook has been reduced to 6.1% in the near term followed by a somewhat higher long term outlook of 9.2% per year in five years, as shown in Table 3.37.

Table 3.37 Growth Forecasts

Forecast	2004	2007
2 Years	13%	6.1%
5 Years	7%	9.2%

3.4.4 Emerging Opportunities

The following opportunities were identified by the public sector respondents.

Table 3.38 Emerging Opportunities

Chesapeake Bay, MSV used in education. Expansion of the Port of Hampton Roads
Research and development that interfaces with other technology clusters in the region, such as sensors, IT and life science.
Serious gaming, Emergency Management, Logistics, Weather & Climate, Medical modeling, Diagnostics, Transportation
Modeling Live, Virtual and Constructive training mix of capabilities based on Individual/unit operational performance
K-16 educational tools
In light of reduced resources (funding and test assets) it is expected that M&S will be increasingly used to support (or augment) live testing. More direct and contractor support will be required. Balance is needed between live versus M&S for weapon system evaluation and acquisition recommendations.

3.4.5 Public Sector MS&V Problems/Issues/Weaknesses

The following statements were included in the survey to further understand issues and problem areas in the region.

In 2004, Table 3.39 indicated that over 80% of public sector respondents moderately or strongly agreed that there is a lack of a trained MS&V labor force in Hampton Roads.

Table 3.39 Public Sector Responses to the statement, “There is a lack of a trained MS&V labor force in Hampton Roads” in 2004

Lack of trained MS&V Labor Force	Percentage
Strongly Agree	6.2%
Moderately Agree	75.0%
No Opinion	12.5%
Moderately Disagree	6.2%
Strongly Disagree	0.0%

In 2007, the situation has improved significantly with only 36% concerned about the MS&V labor force as shown in Table 3.40.

Table 3.40 Public Sector Responses to the statement, “There is a lack of trained MS&V labor force in Hampton Roads” in 2007

Lack of trained MS&V Labor Force	Percentage
Strongly Agree	0.0%
Moderately Agree	35.7%
No Opinion	35.7%
Moderately Disagree	28.6%
Strongly Disagree	0.0%

In 2004, over 80% of public sector respondents strongly or moderately agreed that there was a lack of trained support staff.

Table 3.41 Public Sector responses to the statement, “There is a lack of trained support staff for MS&V in Hampton Roads” in 2004

Lack of trained support staff for MS&V	Percentage
Strongly Agree	18.8%
Moderately Agree	62.5%
No Opinion	6.2%
Moderately Disagree	12.5%
Strongly Disagree	0.0%

In 2007, this concern had dropped to only 29% of the public sector organizations that responded to the survey, as shown in Table 3.42.

Table 3.42 Public Sector responses to the statement, “There is a lack of trained support staff for MS&V in Hampton Roads” in 2007

Lack of trained support staff	Percentage
Strongly Agree	0.0%
Moderately Agree	28.6%
No Opinion	50.0%
Moderately Disagree	21.4%
Strongly Disagree	0.0%

In 2004, there was little agreement on the availability of infrastructure to support MS&V in Hampton roads as shown in Table 3.43.

Table 3.43 Public Sector Responses to the statement, “There is a lack of infrastructure in Hampton Roads to support MS&V” in 2004

Lack of Infrastructure	Percentage
Strongly Agree	18.7%
Moderately Agree	25.0%
No Opinion	6.2%
Moderately Disagree	50.0%
Strongly Disagree	0.0%

In 2007, opinion remains divided, as shown in table 3.44.

Table 3.44 Public Sector Responses to the statement, “There is a lack of infrastructure in Hampton Roads to support MS&V” in 2007

Lack of infrastructure	Percentage
Strongly Agree	0.0%
Moderately Agree	28.6%
No Opinion	35.7%
Moderately Disagree	35.7%
Strongly Disagree	0.0%

3.4.6 Gaps, Weaknesses or Needs

In 2004, respondents were asked to identify all of the following gaps, weaknesses or needs that were applicable to their organization. Table 3.45 indicates relatively uniform concerns in all categories.

Table 3.45 Gaps, Weaknesses, or Needs Identified by Public Sector Respondents in 2004

Gaps, Weaknesses or Needs	Percentage
Technology	20%
Standards	20%
Accreditation	15%
Certification	20%
Networking Opportunities	20%
Other	10%

In 2007, increased concern was expressed about standards and networking opportunities, as shown in Table 3.46.

Table 3.46 Gaps, Weaknesses, or Needs Identified by Public Sector Respondents in 2007

Gaps, Weaknesses or Needs	Percentage
Technology	14.3%
Standards	42.9%
Accreditation	21.4%
Certification	14.3%
Networking Opportunities	35.7%
Other	35.7%

The following suggestions were made for improvement.

Table 3.47 Public Sector Respondents' Suggestions for Improvement

Technology	Standards	Accreditation	Certification
Regular MS&V Forums	Adoption of uniform codes	Funding for upgrades	Nested Enterprise Architectures/ SOA approaches
DoD/JFCOM needs to establish and enforce standards for cross service M&S Systems, data bases and networks	Workshops for different communities of interest	Standardized process	
Funding for upgrades	Test and Evaluation against interoperable standard		
Development of standards for systems modeling and simulation	What amount of V&V is required and how should it be performed?		
Development of accredited programs			
Enterprise level strategies			

4. Economic Impact Analysis

Employment and salary data were provided to the Hampton Roads Planning District Commission for calculation of the regional economic impact using models developed by Regional Economic Models Inc. (REMI). The data was segmented by the Peninsula and South Hampton Roads to match the economic data in the model. The allocation of employment and salary data by sector and geography is provided in Appendix V.

The REMI model is able to simulate future changes to a regional economy, forecasting growth for several years. Since the study was conducted in 2004, the REMI model has undergone four updates, advancing from version 5.5, through versions 6.0, 7.0, 8.0 and now 9.0. These updates were made to improve the accuracy of the system, to account for changes in various industries' impact, and most importantly for this study, to shift from the Standard Industrial Classification (SIC) system for categorizing workforce members to the North American Industrial Classification System (NAICS). The NAICS has replaced the SIC system and is now used by the federal government and the U.S. Census Bureau. The NAICS was developed jointly by the United States, Canada, and Mexico. SIC codes do not relate directly to NAICS codes.

Neither the SIC or NAICS codes identify modeling and simulation professionals as a separate category. Users of REMI models must assign professionals to fields most closely resembling the work done in modeling and simulation. When the 2007 data is analyzed using the current REMI model (version 9.0), it shows significant growth, and this growth is substantiated by the input data. However, the values for economic impact are only slightly larger than those seen in 2004, a result that is not consistent with the increase in the input data. This inconsistency is largely a result of shifting from SIC to NAICS codes. In 2004, employment data were distributed among three SIC codes: Engineering and Architectural Services (60.2%), Research and Test Services (11.2%) and computer and Data Processing Services (28.6%). The NAICS code used in 2007 is Computer Systems Design, Related Services," code 5415.

To address the comparison problem, a REMI staff member, Mr. Billy Leung, Manager for Economics and Business Development, stated that:

“Results from REMI model 5.5 cannot be directly compared with the results using newer model versions. It is not appropriate to compare different versions' results of the REMI model due to changes and updates of the REMI models from year-to-year. Instead, comparisons should be made with both sets of data being analyzed using the same model version.”

He stated that Version 8.0 is able to analyze both the 2004 data and 2007 data. It is therefore used in this report for comparison purposes.

4.1 Economic Impacts

Results of the analysis of the data using REMI Version 8.0 are shown in Table 4.1.

Table 4.1 Economic Impacts using REMI Model Version 8.0 (constant 2000 dollars)

Factor	2004	2007	% Change
Output	258.4	364.6	41.1
Gross Regional Product	167.3	237.8	42.1
Employment	3,524	4,420	25.4
Average Annual Salary	\$60,212	\$82,733	37.4

Table 4.2 Forecasted Annual Job Growth Rate

PERIOD	2004	2007
Two Years	14.2%	7.3%
Five Years	12.3%	14.5%

The following conclusions can be made from these results:

- ◆ The MS&V industry continues to be an increasingly important sector in the regional economy, as measured by the 42.1 percent increase in its contribution to Gross Regional Product, the 41.1 percent increase in the industry's contribution to Total Output, and the 25.4 percent increase in Total Employment.
- ◆ There has been substantial growth in average salaries in the industry, increasing at an average of 12.5% per year and exceeding the average salary in Hampton Roads (\$38,428) by 133 percent
- ◆ The average annual job growth rate of 8.9 percent is significant, although less than the 14.2 percent forecasted in 2004

Growth rate expectations over the next two years are slightly lower than projected in 2004, but higher rates are expected in the future.

For reference, the 2007 data were also run on the same REMI version used in 2004. The results are summarized in Table 4.3. These results are provided to allow a comparison of the previously published results with results from current data.

Table 4.3 Economic Impact using REMI Model Version 5.5

FACTOR	2004	2007	% Change
Total Output	\$412.9m	\$639.5m	54.9
Gross Regional Product	\$248.0m	\$408.1m	64.6
Employment	4,023	5,092	26.6
Average Annual Salary	\$60,212	\$82,733	37.4

Note that Model Version 5.5 indicates larger growth in output and gross regional product than Version 8.0. The 12.4% reduction in employment data reported in 2004 from 4,023 (Version 5.5) to 3,524 (Version 8.0) can be attributed largely to the change in the model from SIC to NAICS codes.

The detailed output from the 2004 REMI model Version 5.5 using Standard Industrial Classification (SIC) codes comparing 2004 and 2007 data is shown in Table 4.4.

Table 4.4 Output from REMI Model 5.5 Comparing 2004 and 2007 Data

The Economic Impact of Modeling and Simulation on Hampton Roads					
	2004 Data SIC Model		2007 Data SIC Model		
	2004	2009	2007	2009	2012
Output (millions of 2004\$s)			Output (millions of 2007\$s)		
Durable Goods Manufacturing	\$18.0	\$33.7	\$32.4	\$36.9	\$55.4
Non-Durable Goods Manufacturing	\$6.3	\$9.2	\$9.0	\$9.2	\$13.1
Mining	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
Construction	\$33.6	\$51.6	\$49.0	\$52.5	\$76.2
Transportation & Public Utilities	\$11.1	\$21.5	\$17.6	\$20.9	\$33.7
Finance, Insurance, and Real Estate	\$35.8	\$57.4	\$53.6	\$57.6	\$86.2
Retail Trade	\$34.9	\$62.3	\$51.3	\$58.7	\$90.8
Wholesale Trade	\$11.6	\$20.4	\$17.9	\$20.3	\$31.0
Services	\$260.7	\$506.0	\$407.4	\$484.5	\$774.8
Agriculture, Forestry, and Fishing Services	\$1.0	\$1.7	\$1.4	\$1.6	\$2.5
Government	NA	NA	NA	NA	NA
Total	\$412.9	\$763.8	\$639.5	\$742.3	\$1,163.6
Gross Regional Product (millions of 2004\$s)			Gross Regional Product (millions of 2007\$s)		
Consumption	\$147.6	\$300.2	\$232.2	\$286.6	\$472.4
Fixed Investment	\$96.2	\$159.2	\$173.9	\$195.2	\$289.1
CBI net IVA + MISC	\$0.6	\$0.1	\$0.8	\$0.9	\$1.2
Government	\$3.6	\$22.3	\$5.4	\$14.9	\$31.1
Exports	\$204.5	\$364.9	\$313.6	\$364.1	\$571.4
Imports	\$204.5	\$382.0	\$317.9	\$378.1	\$597.2
Total	\$248.0	\$481.7	\$408.1	\$483.5	\$768.0
Fiscal (millions of 2004\$s)			Fiscal (millions of 2007\$s)		
State Tax Revenue	\$23.8	\$53.9	\$34.5	\$43.1	\$70.1
State Public Expenditures	\$1.7	\$15.3	\$2.5	\$8.8	\$19.1
Net	\$22.0	\$38.6	\$32.1	\$34.3	\$51.0
Local Tax Revenue	\$9.5	\$28.4	\$13.7	\$20.4	\$36.5
Local Public Expenditures	\$2.4	\$17.3	\$3.5	\$10.2	\$21.5
Net	\$7.0	\$11.2	\$10.2	\$10.2	\$15.0
Employment			Employment		
Durable Goods Manufacturing	28	13	35	24	18
Non-Durable Goods Manufacturing	26	33	31	30	40
Mining	0	0	0	0	0
Construction	289	396	346	354	487
Transportation & Public Utilities	43	66	54	58	83
Finance, Insurance, and Real Estate	134	177	162	159	215
Retail Trade	628	1,004	764	833	1,202
Wholesale Trade	70	98	84	87	117
Services	2,729	4,737	3,518	3,969	5,984
Agriculture, Forestry, and Fishing Services	29	52	39	44	68
Government	47	276	60	162	331
Total	4,023	6,852	5,092	5,719	8,545
Population	765	4,386	1,789	3,407	5,286

¹ Note that the calculation of Gross Regional Product in 2004 did not include exports and imports. They were, however, included in the 2007 calculations. Had they been included in 2004, the value for 2009 would be 464.7 rather than 481.7

Detailed results for the 2007 data using REMI's Version 9.0 are provided in Table 4.5 so that future updates can be compared to the 2007 data. This analysis used NAICS code 5415, "Computer Systems Design and Related Services."

In summary, changes in structure and the addition of refinements of economic models to improve their accuracy will always make it difficult to make direct year-to-year comparisons. However, the multiple comparisons presented makes it clear that the modeling, simulation and visualization industry in Hampton Roads has grown substantially over the past three years and can be expected to continue its growth in the future.

Table 4.5 Detailed output – 2007 Data in REMI Model Version 9.0

Output (Millions of 2007\$s)	New Data & New Model		
	2007	2009	2012
Utilities	\$ 4.2	\$ 5.2	\$ 8.0
Construction	\$ 18.2	\$ 35.8	\$ 56.6
Manufacturing	\$ 8.8	\$ 9.1	\$ 12.7
Wholesale Trade	\$ 9.0	\$ 11.7	\$ 20.0
Retail Trade	\$ 33.8	\$ 44.4	\$ 74.7
Information	\$ 10.5	\$ 13.5	\$ 23.2
Finance, Insurance	\$ 9.9	\$ 10.5	\$ 15.1
Real Estate, Rental, Leasing	\$ 13.5	\$ 11.8	\$ 11.7
Profess, Tech Services	\$ 272.2	\$ 339.1	\$ 578.9
Mngmt of Co, Enter	\$ 3.0	\$ 3.7	\$ 6.1
Admin, Waste Services	\$ 12.3	\$ 15.5	\$ 26.3
Health Care, Social Asst	\$ 8.6	\$ 12.3	\$ 22.2
Accom, Food Services	\$ 13.8	\$ 16.3	\$ 24.8
Other (excl Gov)	\$ 15.8	\$ 18.9	\$ 29.7
Total	\$ 433.8	\$ 547.6	\$ 909.8
Gross Regional Product (Millions of 2007\$s)			
Total Consumption	\$ 207.7	\$ 267.7	\$ 444.6
Total Fixed Investment	\$ 30.6	\$ 64.9	\$ 111.3
CBI net IVA+MISC	\$ 0.1	\$ 0.1	\$ 0.0
Exogenous Final Demand	\$ -	\$ -	\$ -
Total Government	\$ 5.4	\$ 15.5	\$ 33.8
Total Exports	\$ 274.2	\$ 329.3	\$ 548.8
Total Imports	\$ 200.8	\$ 272.9	\$ 457.0
Total GRP	\$ 317.2	\$ 404.6	\$ 681.6
Employment			
Wholesale Trade	50	57	80
Retail Trade	474	569	844
Information	42	48	71
Finance, Insurance	55	51	64
Real Estate, Rental, Leasing	37	32	32
Profess, Tech Services	2214	2542	3838
Admin, Waste Services	261	313	493
Educational Services	45	52	80
Health Care, Social Asst	150	194	320
Arts, Enter, Rec	33	36	51
Accom, Food Services	315	364	536
Other Services (excl Gov)	215	246	360
Manufacturing	24	19	18
Construction	183	348	518
State & Local Gov	63	177	374
Other	39	42	56
Total	4201	5089	7735
Population	968	2726	5736

Appendix I: Hampton Roads MS&V Definitions

The following definitions for Modeling, Simulation and Visualization (MS&V) were used in the study.

Model. A model is a physical, mathematical, or otherwise logical representation of a system, entity, phenomenon or process.

Simulation. Simulation is a methodology for extracting information from a model by observing the behavior of the model as it is executed.

Visualization. Visualization is a method for extracting visual information from data.

Modeling, Simulation, and Visualization (MS&V). Modeling and simulation refers to the process of developing a model and then applying simulation to extract information from the model. Visualization often is used to enhance the user's ability to understand, interpret, and interact with the data associated with modeling and simulation.

MS&V Applications. Modeling, simulation, and visualization is used for analysis, experimentation and training. Analysis refers to investigation of the behavior of a model under conditions within or at the design boundaries; experimentation refers to the investigation of the behavior of a model under conditions that exceed the design boundaries; training refers to the development of skills and knowledge required by individuals to operate or maintain the system represented by the model.

MS&V Organizations. Modeling, simulation, and visualization organizations are organizations that develop tools and technologies, provide services, or use modeling, simulation, and visualization services or products.

Appendix II: Survey Cover Letter

The following letter introduced the survey to respondents when they entered the Survey Monkey web site.



The Modeling, Simulation and Visualization Economic Impact Survey conducted in 2004 impressed us all with the importance of this industry for our region. It also achieved national recognition for Hampton Roads as an important center for research and applications, supported the formation of the Congressional Caucus on Modeling and Simulation, initiated new support programs by state government,, created a new consortium for marketing homeland security and military organizations, and it continues to serve as an effective economic development tool.

We now need to update the survey to provide a benchmark for measuring growth rates in both the public and private sectors and to gage the growth of diversity of applications – military, space, science, transportation, medical, games, maritime and others. Please take a few minutes to complete this important survey. Your participation will:

- Assist in attracting and creating new companies and government agencies in Hampton Roads that support the industry
- Help attract both state and federal government funds for research and applications
- Support the growth of communications among the participants in the industry and its support network

Your responses will be treated as confidential information. Only aggregated data will be published. In addition, all participants will be provided with an Executive Summary of the final report.

You may direct questions to Jonathan Fegely at ANGLE Technology at (412) 719-3145. His email address is jonathan.fegely@angletec.com. The deadline for completing the survey is June 15, 2007.

Your participation is extremely important for supporting the continuing growth of the modeling, simulation and visualization industry in Hampton Roads. Thank you for your help.

Sincerely,

Michael L. McGinnis, PhD
Executive Director
Virginia Modeling, Analysis, and Simulation Center

Appendix III: Survey Questionnaire

The 2007 public sector survey form is included below from the Survey Monkey web site. The private sector survey form is substantially similar.



VMASC Public Sector Survey

1. Organization:

* 2. Business Unit:

* 3. Name of person completing Survey:

* 4. Location of principal business unit:

Peninsula

Southside

* 5. Are there business units or divisions, other than your own, operating in Hampton Roads?

Yes

No

6. If yes, please identify:

*7. Are there other business units or divisions, other than your own, supporting MS&V outside of Hampton Roads?

Yes

No

Survey Form

* 8. Current number MS&V of employees in Hampton Roads:

1 – 10

11 – 25

26 – 100

101 – 500

501 – 1000

1001 – 2000

Over 2001

9. Years your organization have been in operation in Hampton Roads:

Less than 3 years

3 – 5 years

6 – 10 years

More than 10 years

* 10. MS&V Focus of Your Organization (Check all that apply):

Analysis

Training

Experimentation

Acquisition

Education

Engineering

Other (please specify)

Survey Form

* 11. MS&V role your organization provides in Hampton Roads:

End User

Service Provider

Developer

Support

Research

Other (please specify)

* 12. Estimated total wages for MS&V employees in Hampton Roads:
(Based on full-time equivalent employees using labor categories below as a guideline; please do not include contractor employees; please use “unburdened” labor rates for your estimates)

* 13. Number of full-time MS&V employees in Hampton Roads:

* 14. Number of part-time MS&V employees in Hampton Roads:

Survey Form

* 15. Please estimate the approximate distribution of labor functions across your MS&V workforce:

(in percentage – ALL boxes must be completed)

Technology Manager	<input type="text"/>
Systems Engineer	<input type="text"/>
Software Engineer	<input type="text"/>
Information Technologist	<input type="text"/>
Database Administrator	<input type="text"/>
Administrative Support	<input type="text"/>
Other	<input type="text"/>
Total	<input type="text"/>

* 16. Estimated annual percentage change (+/-) in number of MS&V jobs expected over the next 2 years?

* 17. Estimated annual percentage change (+/-) in number of MS&V jobs expected over the next 5 years?

SECTOR ANALYSIS INFORMATION

18. Key MS&V Suppliers/Vendors to your organization, e.g.. hardware and software vendors, MS&V Developers, IT support, etc?

Survey Form

19. Key end users and customers for your MS&V activities, e.g.. DoD, etc?



20. What are emerging MS&V opportunities in Hampton Roads?



IDENTIFICATION OF M&S PROBLEMS/ISSUES/WEAKNESSES

* 21. There is a lack of trained MS&V labor force in Hampton Roads.

Strongly Agree	Moderately Agree	No Opinion	Moderately Disagree	Strongly Disagree
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* 22. There is a lack of trained support staff for MS&V in Hampton Roads.

Strongly Agree	Moderately Agree	No Opinion	Moderately Disagree	Strongly Disagree
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* 23. There is a lack of infrastructure in Hampton Roads to support MS&V.

Strongly Agree	Moderately Agree	No Opinion	Moderately Disagree	Strongly Disagree
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24. If you strongly or moderately agree to any of the above, what needs to be done?



Survey Form

*25. Are there other “gaps”/weaknesses or needs in conducting MS&V activities in your organization? Please specify. (Check those that apply)

Technology

Standards

Accreditation

Certification

Networking opportunities

Other (please specify)

26. Please suggest solutions to address any of the gaps/weaknesses and/or problems identified above:

Technology

Standards

Accreditation

Certification

Networking
opportunities

Other

27. Please comment on any other pertinent information we should be aware of for this survey.

Thank you for your participation in the Hampton Roads MS&V Economic Impact Survey. The results of this survey are confidential; answers are compiled and reported in aggregated data to the Hampton Roads Planning District Commission. An executive summary, including aggregated results and findings, will be provided to all respondents.

Appendix IV Survey Respondents

The following organizations responded to the survey in 2004.

Table Apx IV.1 Survey Respondents in 2004

Public Sector	Private Sector
Army Training Support Center	Aerotech
COMOPTEVFOR	Allied Technology Group
Eastern Virginia Medical School	Amerigroup
Expeditionary Warfare Training Group, Atlantic	Analytical Mechanics Associates, Inc
US Joint Forces Command	Anteon
NASA	AVID LLC
Naval Network Warfare Command	BAE Systems
Old Dominion University	Bihrl Applied Research
SDDC Transportation Engineering Agency	BMH Associates, Inc
Tidewater Community College	Boeing Aerospace Support
	Chesapeake General Hospital
	Collier Research and Development
	Continental Properties
	Cubic Applications Inc
	DDL Omni Engineering LLC
	Food Lion, LLC
	General Dynamics
	GSS, formerly Issue Trak
	Kaufman & Canoles, PC
	Lockheed Martin
	MCRI
	Malcolm Pirnie, Inc
	MTC Technologies
	MYMIC LLC
	Norfolk State University
	Northrup Grumman
	Novonics Corporation
	Parsons Brinckerhoff
	SAIC
	Spectrum Communications
	SYColeman Corp.
	The Runnymede Corporation
	Top Guard, Inc.
	VRCO, Inc.
	Waterside Capital
	W.M. Jordan Co
	WR Systems Ltd.
	Zel Technologies LLC

The following organizations responded to the survey in 2007.

Table Apx IV.2 Survey Respondents for 2007

Public Sector	Private Sector
Army Accessions Command	Aero Tech Research
Army Training Support Center	Alion Science and Technology (BMH)
COMOPTEVFOR	AMSEC
College of William and Mary	Allied Technology Group
Eastern Virginia Medical School	AVID LLC
ECPI	BBG Incorporated
US Joint Forces Command	Bihrl Applied Research
Military Traffic Management Command	Boeing
NASA	Booz Allen Hamilton
Naval Network Warfare Command	Breakaway Ltd
Norfolk State University	Camber Corp
Old Dominion University	Capstone Corp
Tactical Training Group Atlantic	Collier Research
	Cubic Applications Inc.
	DDL Omni
	Earworks Media
	Emerging Business Solutions
	Evidence Based Research
	General Dynamics AIS
	General Dynamics IT
	L3 CommunicATIONS/SY Coleman
	Lockheed Martin
	MTC Technologies
	MYMIC LLC
	Northrup Grumman
	Novonics
	ProSoft
	Raytheon
	SAIC
	Science & Technology Corporation
	Sonalysts
	Systems Engineering Solutions
	Tidewater Technology Group
	VRCO
	WernerAnderson
	Whitney, Bradley & Brown
	WR Systems
	Zel Tech

The following organizations conduct modeling and simulation activities in Hampton Roads but did not respond to the survey.

Table Apx IV.3 Survey Non-Respondents for 2007

Public Sector	Private Sector
Expeditionary Warfare Training Group Atlantic	Analytical Mechanics Associates
Hampton University	Bearing Point
Jefferson Laboratory	CACI Technology
Marine Corps Forces Atlantic	Karta Technologies
National Institute of Aerospace	Science Systems and Applications
NATO	Scientific Research Corporation
NAVSEA Dam Neck Combat Direction	Spectrum Communications
Norfolk Naval Shipyard	Textron Systems
Tidewater Community College	Wingate Technical Services

Appendix V MS&V Employment and Wage Summary

Table Apx V.1 Employment and Wage Summary for 2004

2004	Public Sector		Private Sector		Total Wages (\$)	Total Employment
	Wages (\$)	Employment	Wages (\$)	Employment		
TOTALS	19,830,880	325	79,246,600	1,334	99,077,480	1,659

Table Apx V.2 Employment and Wage Summary for 2007

2007	Public Sector		Private Sector		Total Wages (\$)	Total Employment
	Wages (\$)	Employment	Wages (\$)	Employment		
Peninsula	76,730,250	799	31,300,000	418	108,030,250	1,217
Southside	14,790,000	258	48,530,000	655	63,320,000	913
TOTALS	91,520,250	1,057	79,830,000	1,073	171,350,250	2,130