Joseph George Caldwell, PhD (Statistics)
Consultant in Statistics and Information Technology
Résumé: International Development Version
1432 N. Camino Mateo, Tucson, AZ 85745-3311 USA
Tel. (001)(520)222-3446 (cell), e-mail: jcaldwell9@yahoo.com

EDUCATION: PhD, Statistics, 1966, University of North Carolina at Chapel Hill, Chapel Hill, NC
BS, Mathematics, 1962, Carnegie-Mellon University, Pittsburgh, PA

Key Qualifications

Management Experience. Organizational, contract and project manager. Management approach: Standards-based quality management (ISO 9000). Management positions include: Manager of contract research firm (seven years); successful bidder on numerous technical contracts, including four Small Business Innovation Research (SBIR) contracts; Director of more than twenty technical projects; Adjunct Professor of Statistics at the University of Arizona, Tucson, Arizona; Director of Management Systems (chief information officer) with the Bank of Botswana (Botswana's central bank); Manager of Research and Development and Principal Scientist of US Army Electronic Proving Ground Electromagnetic Environmental Test Facility.

Management Consultant / Consulting Statistician / Research Director / System Developer. Consultant in statistics (experimental design; sample survey design and analysis; descriptive and analytical survey design; time series analysis); optimization (constrained optimization; Lagrangian optimization; game theory); operations research; information technology (systems and software engineering; system development; management information systems (MIS); database design; geographic information systems (GIS); information technology (IT) management); demography (population projections, synthetic estimation); economics (tax policy analysis; cost-benefit analysis; econometrics); program planning, monitoring and evaluation; policy analysis; strategic planning and analysis. Consultant to US government agencies, state governments, corporations and foreign governments. Experience in many application areas, including economics, banking, health, education, social services, industrial operations research and military systems. Director / supervisor of projects in the areas of:

- monitoring and evaluation (M&E); program impact evaluation; planning and policy analysis of government programs in health, education, human services, urban problems, rural development, agriculture and environment; economics (public finance, tax policy analysis, cost-benefit analysis, econometrics); institutional development
- information technology: systems and software engineering; developer of computer models and software packages; management information systems / geographic information systems design and implementation; personnel management information system (PMIS); education management information system (EMIS); database system design and development; data modeling; experienced in use of software development standards, ISO-9000 Quality Management, ISO 12207 Information Technology, Carnegie-Mellon University Software Engineering Institute Capability Maturity Model); engineering (communications-electronics; coding theory).
- international development in Jamaica, Honduras, Ghana, Namibia, Burkina Faso, Guinea, Liberia, Timor-Leste, Zambia, Botswana, Bangladesh, Malawi, Egypt, the Philippines, and Haiti
- operations research and systems analysis in the textile and pharmaceutical industries, civil defense and military applications
- military weapon systems analysis (US Department of Defense and Departments of the Navy, Army and Air Force) in the areas of ballistic missile warfare; naval general purpose forces; naval ocean surveillance; tactical air warfare; communications-electronics; test and evaluation; simulation and modeling; optimization and game theory; system development and automated scenario generation

Teaching and Technical Training. Adjunct Professor of Statistics at University of Arizona; developer and presenter of technical seminars in *Sample Survey Design and Analysis* and *Statistical Design and Analysis in Evaluation*. Training of information-technology professionals (institutional development) in Malawi, Zambia and Botswana (management information systems in Malawi and Zambia, and banking applications in Botswana). Training of professors in impact evaluation in the Philippines.

Note: A detailed curriculum vitae (not restricted to international development) is posted at http://www.foundationwebsite.org/jgccveuformat20161112.pdf.

LANGUAGES: English (native); working knowledge of French and Spanish; limited German and Arabic (for transportation, household use). Rudimentary knowledge of Portuguese (some use in Timor-Leste and Portugal).

COMPUTER LANGUAGES: Statistical program packages (Stata, SAS, SPSS); programming languages (Fortran, C, Visual Basic); database development systems (dBASE, Microsoft Access, SQL, some Oracle, Informix); ESRI ArcView geographic information system (GIS). Much experience with Microsoft Integrated Development Environment (Visual Studio / .NET Framework, Visual Fortran, Visual C, Visual Basic, Visual FoxPro, Front Page). Some experience with Unix-based systems.

GEOGRAPHIC EXPERIENCE: United States of America, Haiti, Philippines, Egypt, Malawi, Canada, Ghana, Bangladesh, Botswana, Zambia, Timor-Leste, Portugal, Guinea, Liberia, Honduras, Germany, Namibia, Burkina Faso, Jamaica.

PROFESSIONAL AFFILIATIONS: Institute for Management Sciences and Operations Research (INFORMS), American Statistical Association, Institute of Mathematical Statistics, American Evaluation Association

HONORS / AWARDS: Tau Beta Pi National Engineering Honorary Society, General Motors Scholarship (Carnegie-Mellon University, Pittsburgh), NASA Fellowship (University of North Carolina at Chapel Hill).

PUBLICATIONS: Over eighty publications in the areas described above, and books on tax reform and global population (list available on request). Many articles on diverse topics (statistics, energy, environment, politics, tax reform, music, guitar, defense, religion / spirituality / philosophy, science fiction). Sample publications (mostly with links for Internet access):

1. Caldwell, J. G., Synchronizable Error-Correcting Codes, Ph.D. Doctoral Dissertation, Institute of Statistics Mimeo Series No. 469, Department of Statistics, University of North Carolina, Chapel Hill, North Carolina, 1966.
2. Bose, R. C. and J. G. Caldwell, "Synchronizable Error-Correcting Codes," Information and Control, 10, 1967. Posted at http://www.foundationwebsite.org/SynchronizableErrorCorrectingCodes.pdf.
3. Caldwell, J. G., T. S. Schreiber, and S.S. Dick, Some Problems in Ballistic Missile Defense Involving Radar Attacks and Imperfect Interceptors, ACDA/ST-145 SR-4, Special Report No. 4, Lambda Corporation / US Arms Control and Disarmament Agency, 1969. Unclassified summary (Optimal Attack and Defense for a Number of Targets in the Case of Imperfect Interceptors, 31 July 2001) of mathematics posted at Internet website http://www.foundationwebsite.org/OptStratTerminalDefense.htm.
4. Caldwell, J. G., Subtractive Overlapping Island Defense with Imperfect Interceptors, ACDA/ST-166, Lambda Corporation / US Arms Control and Disarmament Agency, 1969 (Secret). Unclassified

summary (27 August 2001) of mathematics posted at Internet website http://www.foundationwebsite.org/SubtractiveOverlappingIslandDefense.htm.

5. Caldwell, J. G., Documentation for the time series analysis program: TIMES, Lambda Corporation, 1970. Extract TIMES Box-Jenkins Forecasting System, Reference Manual, Volume I, Technical Background, (revised March 1971,,reformatted September 2006), posted at http://www.foundationwebsite.org/TIMESVol1TechnicalBackground.pdf).
6. Caldwell, J. G., Conflict, Negotiation, and General-Sum Game Theory, Lambda Paper 45, Lambda Corporation, 1970. Reprint posted at Internet website http://www.foundationwebsite.org/Conflict.htm.
7. How to Stop the IRS and Solve the Deficit Problem, book on reform of the US tax system, Vista Research Corporation, Sierra Vista, Arizona, 1987 (427 pages). Republished as The Value-Added Tax: A New Tax System for the United States, posted at Internet web site http://www.foundationwebsite.org/VAT.htm .
8. Caldwell, J. G., Can America Survive?, June 6, 1999, November 21, 2000. Book on relationship of global population and environment to fossil fuel availability. Posted at Internet web site http://www.foundationwebsite.org/canam4x.htm . Methodology for large-scale nuclear war posted (Optimal Attack in the Case of No Defense, 17 July 2001) posted at http://www.foundationwebsite.org/OptStratNoDefense.htm.
9. Caldwell, J. G., How to Play the Guitar by Ear (for mathematicians and physicists), 6 February 2000, updated 3 November 2002. Posted at Internet web site http://www.foundationwebsite.org/Guitar.htm. Related article, How to Play the Guitar by Ear in Six One-Hour Lessons (21 August 2008, updated 30 August 2008) posted at http://www.foundationwebsite.org/HowToPlayTheGuitarByEar6HourCourse.htm . Summary of Music Theory (11 May 2002) posted at http://www.foundationwebsite.org/MusicTheorySummary.htm.
10. Caldwell, J. G., DESTINY 2005 Demographic Estimation, Forecasting and Analysis System, Description of Capabilities, International Version 3.0.01, 1982, 1995, December 26, 2005, posted at http://www.foundationwebsite.org/DestCapINTL.pdf.
11. Caldwell, J. G., A Lagrangian Approach to Customer Relationship Management: Variable-Rate Pricing Strategy, 9 August 2006. Posted at Internet web site http://www.foundationwebsite.org/LagrangianApproachToCRM.htm.
12. Caldwell, J. G., The Box-Jenkins Forecasting Technique, June 1971, reformatted September 2006. Posted at http://www.foundationwebsite.org/BoxJenkins.pdf.
13. Caldwell, J. G., Sample Survey Design for Evaluation (The Design of Analytical Surveys, 20 March 2009, updated 16 June 2010, posted at http://www.foundationwebsite.org/SampleSurveyDesignForEvaluation.pdf.
14. Caldwell, J. G., Determination of Sample Size for Analytical Surveys, Using a Pretest-Posttest-Comparison-Group Design, 19 August, 2011, posted at http://www.foundationwebsite.org/SampleSizeEstimationAnalyticalSurveysGeneric.htm.
15. Design Report, Design and Implementation of MCA Honduras Program Evaluation, NORC at the University of Chicago (Chicago, IL and Bethesda, MD), Millennium Challenge Corporation, Washington, DC., April 10, 2011. Posted at Internet web site http://www.mcc.gov/documents/reports/report-042011-design-hon-transportation-and-farmer-training.pdf.
16. Final Report (Revised), Impact Evaluation of the Farmer Training and Development Activity in Honduras, Millennium Challenge Corporation Contract MCC-10-0133-CON20TO01, NORC at the University of Chicago (Chicago, IL and Bethesda, MD), Millennium Challenge Corporation, Washington, DC, November 26, 2013. Posted at Internet web site http://www.mcc.gov/where-we-

work/independent-evaluations/honduras-compact/ .

17. Revised Final Report, Impact Evaluation of the Transportation Project in Honduras, Millennium Challenge Corporation Contract MCC-10-0133-CON20TO01, NORC at the University of Chicago (Chicago, IL and Bethesda, MD), Millennium Challenge Corporation, December 20, 2013. Posted at Internet web site http://www.mcc.gov/where-we-work/independent-evaluations/honduras-compact/ .

PRINCIPAL POSITIONS (generally of duration 18 months or more):

Consultant in Statistics, Optimization and Information Technology, 1974-present (various organizations, including National Opinion Research Center at the University of Chicago (NORC), The Mitchell Group, Sanigest, Academy for Educational Development (AED), Chemonics, Wells Fargo Bank, Bank of Botswana, United Nations Development Program (UNDP), contractors of United States Agency for International Development (USAID), Millennium Challenge Corporation (MCC), Inter-American Development Bank (IDB),African Development Bank (AfDB), Asian Development Bank (ADB))
Software Engineer (Developer of Education Management Information System (EMIS)), Academy for Educational Development, Lusaka, Zambia, 2002-05
Director, Management Systems Department, Bank of Botswana, 1999-2001
Software Engineer (Developer of national civil service Personnel Management Information System (PMIS)), Academy for Educational Development, Lilongwe, Malawi, 1993-94
President and Manager, Vista Research Corporation, Tucson and Sierra Vista, AZ, 1988-91
Adjunct Professor of Statistics, University of Arizona, Tucson, AZ, 1982-86 (taught the graduate course in sample survey design and analysis and the core statistics course for students in business, public administration and management information systems)
Director of Research and Development and Principal Scientist of US Army Electronic Proving Ground's Electromagnetic Environmental Test Facility, Bell Technical Operations and Combustion Engineering, Tucson and Sierra Vista, AZ, 1982-86, 1986-88
Principal Engineer, SINGER Systems and Software Engineering, Tucson, AZ, 1986
President and Manager, Vista Research Corporation, Alexandria, VA, and Tucson, AZ, 1977-81
Vice President, JWK International Corporation, Annandale, VA, 1974-76
Principal, Planning Research Corporation, McLean, VA, 1972-74
Member of the Technical Staff, Lambda Corporation / General Research Corporation, McLean, VA, 1967-72
Senior Operations Research Analyst, Deering Milliken Research Corporation, Spartanburg, SC, 1966-67
Operations Research Analyst, Research Triangle Institute, Research Triangle Park, NC, 1964-66

Date of Birth: 23 March 1942
Nationality: United States of America and Canada
Residence: 1432 N. Camino Mateo, Tucson, AZ 85745-3311 USA

Summary of Professional Experience

The following paragraphs describe Dr. Caldwell's experience and approach in six areas, in greater detail: (1) statistical consulting; (2) management approach; (3) statistical applications in monitoring and evaluation; (4) operations research, systems analysis and statistics in industrial, commercial and military applications; (5) systems and software engineering; (6) teaching and technical training.

1. Statistical Consulting

Consultant in statistics, specializing in the design of analytical surveys for impact evaluation of programs and projects in the US and foreign countries. Design techniques combine the methodologies of experimental design and sample survey design. Applications include experimental designs (randomized assignment of treatment), quasi-experimental designs (structure similar to experimental designs, but

lacking randomized assignment of treatment) and observational data. Analytical survey designs use marginal stratification (implemented using variable probabilities of selection) to achieve adequate variation (balance, spread, orthogonality) in explanatory variables, and multidimensional matching to reduce bias and increase precision. Use statistical power analysis to determine sample size. National-level monitoring systems and impact evaluations implemented in the US and a number of developing countries (listed above). Sample survey designs include design-based approach (for descriptive surveys, used in program monitoring) and model-based approaches (for analytical surveys, used in program evaluation).

Analysis is based on causal modeling using the Neyman-Rubin conceptual framework (counterfactuals model, potential outcomes model). Many applications involve pretest-posttest-comparison-group designs using the double-difference estimator of program impact. Analysis involves the use of complex estimators, such as a two-step estimator based on a first-step selection model and a second-step outcome model (e.g., a propensity score based estimator). Analysis involves heavy use of econometric modeling, as described in *Econometric Analysis* 7th ed. By William H. Greene (Prentice-Hall, 2012) and *Econometric Analysis of Cross Section and Panel Data* 2nd ed. by Jeffrey M. Wooldridge (MIT Press, 2010, 2002). Numerical calculations are done using the Stata statistical programming package.

Dr. Caldwell has been active in the design of analytical surveys since the mid-1970s. In the 1970s he designed a number of national-level analytical survey designs in the United States and directed the *Economic and Social Impact Analysis / Women in Development* project in the Philippines (providing training in impact evaluation of development projects). His approach to analytical survey design combines aspects of experimental design and sample survey design. For quasi-experimental designs involving matching of sample units of treatment and control samples, his approach overcomes the intrinsic shortcoming of the popular propensity-score-matching (PSM) procedure, that sample units may match well on the propensity score but not match well on variables ("covariates") that have an important effect on outcomes of interest, resulting in low precision for impact estimates (the so-called "balancing" problem). His methodology for designing analytical surveys is presented in the article, *Sample Survey Design for Evaluation (The Design of Analytical Surveys)*, posted at Internet web site http://www.foundationwebsite.org/SampleSurveyDesignForEvaluation.pdf.

As part of his statistical consulting practice he has presented seminars on sample survey design and analysis, and he posts articles and software on statistics and related topics on his website, http://www.foundationwebsite.org (such as a program to estimate sample sizes for analytical surveys – see below for links to these, in the section on Teaching and Technical Training).

2. Management Approach: Standards-Based Quality Management

Management Consulting / Business Experience. Dr. Caldwell has substantial experience in management consulting to industry, including consulting, training, and system development in forecasting, quality control, product improvement, process control, and economic analysis of production alternatives. He founded and managed his own contract research firm (Vista Research Corporation, operated full-time for seven years), and set up a ladies' fashions importing/retailing firm (Sonora Marketing Corporation). In these efforts, Dr. Caldwell designed, implemented and managed all major functional components of the operations (marketing, production, and finance).

Standards-Based Quality Management. For larger projects, Dr. Caldwell employs a "standards-based quality management" approach to project management. This approach makes full use of internationally

recognized management and technical standards that are applicable to the effort. Examples of projects that he directed that employed this approach are the following:

- Manager of Research and Development and Principal Scientist, US Army Electronic Proving Ground's Electromagnetic Environmental Test Facility. In this role, all of the engineering and software development efforts directed by Dr. Caldwell were conducted in conformance with applicable US military standards (software development, systems engineering, test and evaluation).
- Personnel Management Information System (PMIS) for the Government of Malawi. This project, which developed the personnel management information system for the Malawi civil service, was conducted in strict compliance with the leading software development standard at the time, the US Department of Defense's Defense Systems Software Development, DOD-STD2167A, which was the predecessor to today's international information-technology standard, ISO 12207, Software Life Cycle Processes.
- Research in Artificial Intelligence for Noncommunications Electronic Warfare Systems. The purpose of this project was to develop an automated system for generating military scenarios for use in testing of military electronic-warfare systems. This project was developed in full compliance with the DOD-STD2167A Defense Systems Software Development Standard.
- Director of Management Systems for the central bank of Botswana. As Director of Management System for the Bank of Botswana, Dr. Caldwell introduced a number of quality-management initiatives, including:
    - Direction of the Bank's Year-2000 program using guidelines published by the US General Accounting Office ("Year 2000 Computing Crisis: Business Continuity and Contingency Planning") and the Bank for International Settlements. As a result of this program, the Bank did not experience a single "Year 2000 date change" problem.
    - Use of the ISO 12207 Information Technology Standard to guide all major software development and acquisition efforts (such as the effort to acquire a national code-line clearing system based on magnetic-ink character recognition of checks, and the project to acquire a computer network management system for the Bank).
    - Initiation of an effort to have the Bank's Management Systems Department operate in compliance with the ISO 9000 Quality Management Standard.
    - Assessment of the software development capability of the Bank's staff and its software suppliers using the Carnegie Mellon University Software Engineering Institute's Capability Maturity Model (CMM) (predecessor of the ISO 15504 Standard, Software Process Improvement and Capability Determination ("SPICE")).
    - Direction of the project to develop the Bank's Business Continuity Plan / Disaster Recovery Plan, using the Business Continuity Planning Guidelines issued by the Texas Department of Information Resources.
    - Direction of the project to develop an information technology security plan, using the US General Accounting Office's Information Security Risk Assessment guidelines.

In addition to providing assurance that work conducted in compliance with international professional standards will be of high quality, one of the other distinct benefits of using standards-based quality management is that staff members benefit greatly from being provided the opportunity and experience of working in compliance with quality management and technical standards.

3. Statistical Applications in Program Monitoring and Evaluation

Dr. Caldwell developed the design for many national sample surveys and statistical reporting systems. He specializes in the development of analytical survey designs to collect data for model development, and developed new techniques for handling nonresponse in longitudinal surveys. An article describing Dr.

Caldwell's approach to the design of analytical surveys (e.g., for impact evaluation of economic and social development programs) is posted at http://www.foundationwebsite.org/SampleSurveyDesignForEvaluation.pdf , and a computer program for determining sample sizes for complex surveys is posted at http://www.foundationwebsite.org/JGCSampleSizeProgramV53_20130917.accde (a Microsoft Access program).

Program monitoring surveys and reporting systems include:

- Zambia Education Management Information System (EMIS)
- Ghana Trade and Investment Program Survey
- Malawi Annual Primary School Enrollment Survey
- Malawi Civil Service Personnel Management Information System (PMIS)
- National Center for Health Services Research Hospital Cost Data Study
- Professional Standards Review Organization Data Base Development Study
- Study of Impact of National Health Insurance on Bureau of Community Health Service Users
- 1976 Survey of Institutionalized Persons
- Sampling Manual for Utilization Review of Medicaid
- Sampling Manual for Social Services (Title XX) Reporting Requirements
- Sampling Manual for Office of Child Support Enforcement Reporting Requirements
- Dept. of Housing and Urban Development Housing Market Practices Survey
- Research Design for the Urban Arterials Section of the Highway Capacity Manual
- Elementary and Secondary School Civil Rights Survey

Evaluation Research / Impact Evaluation. Dr. Caldwell developed analytical sample survey designs for impact evaluations in the US, Jamaica, Honduras, Ghana, Burkina Faso, Namibia, Benin, Malawi, Zambia, and Côte d'Ivoire:

- Impact Evaluation of the Programme of Advancement through Health and Education (PATH), Jamaica (a conditional cash transfer program)
- Evaluation of Performance and Impact of Rehabilitation and Intensification of Olive Plantations in Rain-fed Zones, Morocco (Millennium Challenge Corporation)
- Agricultural Data Collection in the Sourou Valley and Comoé Valley, Burkina Faso (Millennium Challenge Corporation)
- Community-Based Rangeland and Livestock Management Household Income and Expenditure Surveys, Namibia (Millennium Challenge Corporation)
- Conservancy Support and Indigenous Natural Products Household and Organisational Surveys, Namibia (Millennium Challenge Corporation)
- Impact Evaluation of Water Supply Activity, Ghana (Millennium Challenge Corporation)
- Monitoring and Evaluation of the Competitive African Cashew Value Chains for Pro-Poor Growth Program in Benin, Burkina Faso, Côte d'Ivoire, Ghana and Mozambique (Deutsche Gesellschaft für Zusammenarbeit (GTZ))
- Monitoring and Evaluation of the Competitive Action Cotton for Pro-Poor Growth Program in Benin, Burkina Faso, Côte d'Ivoire, Zambia, Ghana and Malawi (Deutsche Investions und Entwicklungsgesellschaft (DEG))
- Impact of Feeder Roads Activity, Ghana (Millennium Challenge Corporation)
- Farmer Training and Development Activity, Honduras (Millennium Challenge Corporation)
- Transportation Project, Honduras (Millennium Challenge Corporation)

and directed or supervised the following impact evaluation studies:

- Economic and Social Impact Evaluation / Women in Development in the Philippines

- Manager of Evaluation for Local Development II - Provincial Project in Egypt
- Measuring the Effectiveness of Social Services in West Virginia
- Day Care Cost-Benefit Study
- Vocational Rehabilitation Evaluation Standards Study
- Cost-Benefit Analysis of National Institute for Alcohol Abuse and Alcoholism Treatment Centers
- Medicaid Standards Impact Assessment

Public Finance. In addition to his work in tax policy analysis and cost-benefit analysis, Dr. Caldwell directed studies to develop alternative allocation / matching formulas for major state/federal programs:

- Vocational Rehabilitation State Allocation Formula
- Medicaid and AFDC Matching Percentage Formula

Dr. Caldwell is author of the book, The *Value-Added Tax: A New Tax System for the United States* (1987, 2000). An online copy of this book is posted at Internet web site http://www.foundationwebsite.org/VAT.pdf . This work not only describes a new tax system for the United States, but also presents a new methodology (based on the principles of systems engineering, and called "Tax Engineering") for designing tax systems.

4. *Operations Research, Systems Analysis and Statistics in Industrial, Commercial and Military Applications.*

Dr. Caldwell applied a wide variety of operations research and statistical techniques to solve practical problems in industrial, commercial and applications. Applications include the use of simulation and modeling, optimization and statistical methods to solve problems in process control, forecasting, economic analysis and optimal allocation of resources in industrial, commercial and military applications (textile and pharmaceutical manufacturing, banking, ballistic missile defense, naval ocean surveillance, test and evaluation of military electronic systems and equipment (communications and noncommunications)). These applications often involved the use of state-of-the-art technical methodologies such as (1) application of the Box-Jenkins time-series modeling method for demand forecasting (several years prior to publication of the Box-Jenkins book, *Time Series Analysis, Forecasting and Control*); (2) application of the Generalized Lagrange Multiplier optimization methodology and game theory for solving complex resource allocation problems in military applications and banking (variable-rate loan pricing strategies); (3) application of the just-introduced ArcView 3.0 geographic information system to identify good locations for automated teller machines (ATMs); and (4) application of artificial intelligence and expert systems methodology to develop automated scenario generation models for use in testing of noncommunication electronic warfare systems.

Much of Dr. Caldwell's work involved application of modern methodology to solve difficult problems in resource-constrained optimization, such as applications involving nonlinear, nonconvex and noncontinuous objective functions (in which cases standard techniques such as linear programming are not useful). In some instances, no satisfactory existing solution methodology existed, and new theory was developed. For example, in his work in ballistic missile defense, he developed a computationally feasible method for determining approximate solutions to John Nash's bargaining solution to a general-sum game (Nash's theory presented only an existence proof, not a constructive proof, of the bargaining solution). This work involved basic research in game theory. A reprint of the original report produced by this effort is posted at Internet website http://www.foundationwebsite.org/Conflict.htm.

5. *Systems and Software Engineering*

Dr. Caldwell's work in software engineering includes development of national management information systems, director of information technology for a central bank, and development of specialized computer software programs and packages. Large systems were developed in accordance with applicable software development standards.

Level of Operation. In his information-technology (IT) work, Dr. Caldwell has operated at all organizational and technological levels, from administration, supervision and project direction through system design and implementation. As Director of Management Systems (chief information officer) at the Bank of Botswana, he directed a staff of 16 IT professionals and many projects, including the Year 2000 project, the project to set up a bank disaster recovery / avoidance system, the project to acquire a computer network management system for the Bank, and the project to acquire a magnetic-ink character-recognition (MICR) code-line clearing system for the country's bank checks. As Manager of Research and Development and Principal Scientist at the US Army Electronic Proving Ground's Electromagnetic Environmental Test Facility he directed a staff of 16 scientists and engineers in test and evaluation of military communications-electronics systems, and conducted all work in accordance with US Department of Defense military standards. As manager of Vista Research Corporation he was engaged in all aspects of computer systems development (systems and software engineering), from requirements specification and top-level design through coding and testing. He conducted all aspects of development of the Personnel Management Information System (PMIS) for the Government of Malawi and the Education Management Information System (EMIS) for the Government of Zambia.

Management Approach. For larger projects or operations, he is a strong proponent of "standards-based quality management," which makes heavy use of international standards (ISO 9000 Quality Management, ISO 12207 Information Technology Standard and its predecessors (the US Department of Defense's Software Development Standards (DOD-STD-2167A and MIL-STD-498)), the Carnegie-Mellon University Software Engineering Institute Capability Maturity Model (CMU SEI CMM), and ISO/IEC 15504 (Software Process Improvement and Capability Determination, or "SPICE").

Design Approach. He has directed numerous software engineering projects, applying the modern principles of systems and software engineering. This approach includes user needs analysis, requirements specification and analysis, technology review, synthesis of system alternatives, cost-effectiveness analysis of alternatives and selection of a preferred alternative, detailed design, implementation and test. For the software subsystem he utilizes top-down, structured design combined with rapid prototyping (iterative development).

Here follows a summary of software development projects, ranging from national-level management information systems, general-purpose software programs and packages, and special applications.

National Management Information Systems

- Civil service Personnel Management Information System (PMIS) for Malawi
- Education Management Information System (EMIS) for Zambia

General-Purpose Software Programs and Packages

- Computer program for estimating sample sizes for complex surveys
- *TIMES*, the first commercially available general purpose Box-Jenkins time-series-analysis computer program
- The *DESTINY* system for making population projections and synthetic estimates of quantities related to population
- The *MICROSIM* prototype microsimulation forecasting model for estimating caseloads and budgets in human-service applications
- *SCENARIST* prototype automated scenario generating system (artificial intelligence, expert systems, GRASS geographic information system)

Special Applications

- Computer programs for implementing statistical matching and marginal stratification using variable probabilities of selection
- Variable-rate bank loan pricing model (based on Generalized Lagrange Multipliers (GLM))
- ATM Placement Model (SAS, ArcView GIS)
- Vocational Rehabilitation State Allocation Model
- Correlation / Tracking Model for Naval Ocean Surveillance System
- Terminal Missile Defense with Imperfect Inteceptors (GLM)
- Subtractive Overlapping Island Defense Model (GLM)
- Program for obtaining approximate solutions to John Nash's Bargaining Solution for a General Sum Game (GLM)
- HARDSITE Defense Model (GLM)
- Naval Combat Damage Model (GLM)
- Multiple Resource-Constrained Game Model (GLM)

Details on System Development and Programming Experience

Technology: Development Environments, Operating Systems, Programming Languages and Packages. Dr. Caldwell has extensive hands-on system development experience. His computer experience includes mainframe, mini- and microcomputer applications. He has much experience in applications programming in Fortran, C, Visual C, Visual Basic, dBASE/FoxPro, Microsoft Access and SQL on mainframe computers, minicomputers and microcomputers under a variety of operating systems (MS-DOS, Microsoft Windows, UNIX, IBM, CDC, UNIVAC, Sun Microsystems Solaris and others). Most of his microcomputer development work used the Microsoft Visual Studio Integrated Development Environment (IDE) / .NET Framework. He is experienced in application of database systems (SQL-based relational database systems such as Microsoft Access, Oracle and Informix and Xbase systems such as dBASE and FoxPro), and of statistical program packages (e.g., Stata, SAS and SPSS). He has some experience on Unix operating systems (e.g., Sun Microsystems Solaris) and some familiarity with Unix-related open-source systems (Linux, Apache, MySQL, PHP ("LAMP")). He is familiar with a variety of commercial microcomputer software applications (e.g., word processing, electronic spreadsheet, data base, desktop publishing, web page development, accounting), including the Microsoft Office suite of products (Word, Access, Excel, PowerPoint, FrontPage (HTML web page development system, replaced in 2006 by Microsoft Expression Web and Sharepoint Designer) in both standalone and network environments.

Application Areas (in Software Engineering)

Computer Models for Forecasting and Demographic Analysis. Dr. Caldwell developed *TIMES*, the first commercially-available general-purpose Box-Jenkins computer-forecasting package and the *DESTINY* microcomputer software system for making demographic projections (cohort-component, synthetic estimation) For the US Department of Health and Human Services (HHS), he directed the project to develop a prototype microsimulation forecasting model and a statistical reporting system to provide the data required by the model. The model -- called *MICROSIM* -- was developed to forecast caseloads and expenditures for HHS programs under various policy assumptions.

Artificial Intelligence / Expert Systems / Geographic Information Systems. For the US Army Communications-Electronics Command, he directed a project to develop a prototype expert system, named *SCENARIST*, to position military units and equipment, taking into account the location of friendly and opposing forces, mission, tactical combat rules, and digital terrain data. The system (which included 50,000 lines of C code) incorporated the NASA-developed C-Language Integrated Production System (*CLIPS*) expert system and used digital mapping data extracted from the US Army's Geographic Resources and

Services System (*GRASS*) geographic information system (GIS). The system was developed for MS-DOS-based 80x86 microcomputers, and included a comprehensive graphical user interface (mouse, windows, and menus).

Banking / Finance. He developed a geographic information system application (ArcView 3.0 GIS, SAS) to identify good locations for bank automated teller machines (ATMs). He developed a simulation / optimization system, based on Generalized Lagrange Multipliers, to determine optimal loan pricing strategies (Windows NT, Microsoft Visual Basic 5.0).

Program Evaluation; Civil Service and Education Management Information Systems. Dr. Caldwell personally conducted all of the software and database design and most of the programming for the statistical and information systems work in the Egypt, Malawi (civil service Personnel Management Information System) and Zambia (Education Management Information System) applications mentioned above.

6. Teaching and Technical Training

Dr. Caldwell served as adjunct professor of statistics at the University of Arizona, where he taught the graduate course in sample survey design and analysis and the basic statistics course for all students of business, management, management information systems, and public administration (500 students per semester).

As director of the *Economic and Social Impact Analysis / Women in Development* project in the Philippines, Dr. Caldwell trained university professors in the theory and methodology of program impact evaluation. As part the project to develop the Personnel Management Information system for the civil service of Malawi, he trained IT professionals (in the Office of the President) in the methodology for development and maintenance of a national-level management information system. In Zambia, he trained staff of the Ministry of Education in the technology of development and maintenance of the national Education Management Information System. As Director of Management Systems for the Bank of Botswana (Botswana's central bank), he was responsible for professional development and training of the Bank's information-technology staff.

Dr. Caldwell has developed and presented a number of statistics courses relating to monitoring and evaluation (*Statistical Methods for Monitoring and Evaluation: A Comprehensive Survey Course*). These courses have been presented on an advertised basis and as in-house courses at client facilities (US Bureau of Labor Statistics; National Opinion Research Center; Bahamas Department of Statistics). Course notes for this course are posted at Internet websites
http://www.foundationwebsite.org/StatCourse1&2SampleSurvey3DayCourse.pdf
http://www.foundationwebsite.org/StatCourse3ReviewOfStatisticalInference.pdf
http://www.foundationwebsite.org/StatCourse4&5CausalInferenceAndMatching.pdf
http://www.foundationwebsite.org/StatCourse6&7StatisticalDesignAndAnalysisForEvaluation2DayCourse.pdf
http://www.foundationwebsite.org/StatCourse8SampleSizeDetermination.pdf
http://www.foundationwebsite.org/StatCourse9MissingData.pdf
http://www.foundationwebsite.org/StatCourse10SmallAreaEstimation.pdf

Computer Software in Statistics and Demography.

Computer Software for Time Series Analysis, Forecasting and Control. Dr. Caldwell developed the first commercially-available general-purpose Box-Jenkins computer-forecasting package (*TIMES*, described at

http://www.foundationwebsite.org/BoxJenkins.pdf ,
http://www.foundationwebsite.org/TIMESVol1TechnicalBackground.pdf).
A computer program for developing the most common Box-Jenkins models is posted at
http://www.foundationwebsite.org/BoxJenkinsForecastingProgram.exe.

Computer Software for Demographic Analysis and Synthetic Estimation. Dr. Caldwell developed the *DESTINY* microcomputer software for making demographic projections (cohort-component, synthetic estimation) (described at http://www.foundationwebsite.org/DestCapINTL.pdf; similar to USAID's *RAPID* population-projection program, but extended to handle multiple regions and ethnic groups). The *DESTINY* system uses the cohort-component method of population projection to produce estimates of population by age, sex, race and region, and applies the method of synthetic estimation to determine forecasts of variables related to population.

Statistical Methodology for Evaluation. An article describing Dr. Caldwell's approach to the design of analytical surveys (e.g., for impact evaluation of economic and social development programs) is posted at http://www.foundationwebsite.org/SampleSurveyDesignForEvaluation.pdf, and a computer program for determining sample sizes for complex surveys is posted at http://www.foundationwebsite.org/JGCSampleSizeProgramV53_20130917.accde (a Microsoft Access program). An illustrative example of use of this program is presented in the article *Determination of Sample Size for Analytical Surveys, Using a Pretest-Posttest-Comparison-Group Design*, posted at http://www.foundationwebsite.org/SampleSizeEstimationAnalyticalSurveysGeneric.htm.

PROJECT DESCRIPTIONS (in development applications):

2016, Statistical Consultant, The Mitchell Group. Expert consultant in statistics; sample weighting specialist. SAREL project (USAID). The Sahel Resilience Learning Project (SAREL) and the Resilience in the Sahel Enhanced (RISE) Initiative Baseline Survey are efforts to increase the resilience of chronically vulnerable populations in the agro-pastoral and marginal areas of Burkina Faso and Niger. The RISE survey was a probabilistic household survey o 2,500 households across villages in the Sahel. The survey was a complex sample survey consisting of a stratified first-stage sample of 100 villages and a second-stage sample of 25 households in each selected village. Advised on specification of proper statistical procedures for analyzing the collected survey data, using Stata (*svy* module).

2015, Statistical Consultant, National Opinion Research Center of the University of Chicago (NORC). Sample survey design consulting services (statistical power analysis for sample size determination; sample allocation and selection; calculation of survey weights) to proposals and projects in international development (USAID Burundi Village Savings and Loan Association (VSLA) child welfare project; IADB Honduras Bono 10 Mil conditional cash transfer project; USAID Liberia Electoral Access and Participation (LEAP) project).

March 2014 – July 2014. Statistical Consultant, Inter-American Development Bank / Bahamas Department of Statistics. Development and presentation on a training course on small-area estimation, for the Bahamas Department of Statistics. The purpose of the course is to describe statistical methodology for making estimates of unemployment for the Bahamas Labour Force Survey (conducted in May and November of each year), for small islands or island groups for which the sample size for a particular survey round is small or zero.

June 2011 – November 2012. Economist and Statistical Analyst, Impact Evaluation of the Programme of Advancement through Health and Education (PATH), Jamaica. Government of Jamaica / Sanigest, Costa Rica. Responsible for evaluation and sample survey design used to collect household data to evaluate

Jamaica's PATH conditional cash transfer (CCT) program. Adopted the Neyman-Rubin ("potential outcomes," "counterfactuals") conceptual framework for the evaluation design, and constructed a sample survey design to support this approach. The sample design was an "analytical" sample design intended to provide data useful for estimating program impact and the relationship of impact to explanatory variables. The sample design was a "matched pairs" design that included matching of eligible households on a number of socio-economic characteristics, prior to selection of probability samples of treated and untreated households. Statistical power analysis was used to determine a sample size sufficient to provide a high level of power for detecting impacts of specified magnitude ("minimum detectable effects"). The precision of impact estimates and the power of statistical tests about those impacts were increased by the use of marginal stratification to assure adequate variability on explanatory variables related to outcomes of interest. The marginal stratification was implemented by setting variable probabilities of selection for each household of the population.

September 2010 – September 2012. Evaluation Expert and Statistician to the project, "Evaluation des performances et de l'impact de l'activité de rehabilitation et d'intensification des plantations d'oliviers au niveau des zones pluviales," Agence du Partenariat pour le Progrès, Millennium Challenge Account – Maroc, Project Arboriculture Fruitière, National Opinion Research Center of the University of Chicago (NORC). Responsible for sample survey design and selection of samples for an impact evaluation of an olive development project in Morocco.

August 2010 – July 2012. Evaluation Expert and Statistician to the project, "Agriculture Data Collection in the Sourou Valley and Comoé Basin." Millennium Challenge Account – Burkina Faso (MCA-BF), National Opinion Research Center of the University of Chicago (NORC). Responsible for construction of sample survey design and selection of samples for an impact evaluation of two agricultural development projects in Burkina Faso.

August 2010 – November 2011. Evaluation Expert and Statistician to the project, "Community-Based Rangeland and Livestock Management Household Income and Expenditure Surveys." Millennium Challenge Account – Namibia (MCA-N), National Opinion Research Center of the University of Chicago (NORC). Responsible for construction of sample survey design and selection of samples for an impact evaluation of a rangeland management project in Namibia.

August 2010 – March 2012. Evaluation Expert and Statistician to the project, "Conservancy Support and Indigenous Natural Products Household and Organisational Surveys." Millennium Challenge Account – Namibia (MCA-N), National Opinion Research Center of the University of Chicago (NORC). Responsible for construction of sample survey design and selection of samples for an impact evaluation of an indigenous natural products project in Namibia.

July 2010 – September 2010. Evaluation Expert and Statistician to the project, "Impact Evaluation of Water Supply Activity." Millennium Development Authority—Ghana (MiDA), National Opinion Research Center of the University of Chicago (NORC). The Water Supply Activity project was undertaken by the Millennium Development Authority – Ghana (MiDA) as part of its Compact with the US Millennium Challenge Corporation (MCC) to improve infrastructure in selected agricultural areas in Ghana. The goal of the water supply activity improvements was to improve the quantity and quality of water in MiDA program areas, and thereby improve the health and economic status of communities in those areas. Of particular interest were effects on household health outcomes, time savings, and income levels. The purpose of the evaluation project was to conduct a rigorous impact evaluation of the program to assess the extent to which it achieved its goals. The evaluation design was a pretest-posttest-comparison-group design, and the basic measure of program impact was a double-difference estimate based on this design. Dr. Caldwell constructed the evaluation and survey design for the evaluation project.

November 2009 – October 2010. Evaluation Expert and Statistician to the project, "Monitoring and Evaluation of the Competitive African Cashew Value Chains for Pro-Poor Growth Program", Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, National Opinion Research Center of the University of Chicago (NORC). Here follows a brief summary of the project, taken from the project grant proposal: "The project will contribute to sustainably reducing rural poverty in five African countries (Benin, Burkina Faso, Côte d'Ivoire, Ghana and Mozambique). An estimated 2.5 million mainly smallholder farmers grow cashew in Africa. Annually production of almost 750,000MT they supply about 40% of the world's cashew crop. But only about 12% of cashew nuts are processed into cashew kernels in Africa. The cashew project aims to improve the quality of raw cashew nut cultivation, increase farmer productivity, improve linkages between smallholder farmers and the marketplace, build African processing capacity and promote a sustainable global market for African cashews. The project's goal is to help 150,000 smallholder cashew farming households in Benin, Burkina Faso, Côte d'Ivoire, Ghana and Mozambique increase their incomes by 50 percent by 2012." The goal of the program was to increase income and employment for cashew farmers. The purpose of the evaluation project was to conduct an economic impact evaluation of the program to assess the extent to which it is achieving its goals. For the evaluation, surveys were conducted in all five countries of the program. Dr. Caldwell constructed the evaluation and sample survey designs for all program countries except Mozambique. The measures of program impact were double-difference estimates based on pretest-posttest-comparison-group evaluation designs. Sample sizes were determined by statistical power analysis to assure high power for detecting impact effects of specified size. A two-stage sample design was employed, with selection of a first-stage sample of villages and a second-stage sample of farmers within sample villages. The sample design used matching to increase precision of estimates and power of tests of hypotheses. Marginal stratification, implemented through the use of variable probabilities of selection, was used to assure adequate variation in explanatory variables.

March 2009 – March 2013. Evaluation Expert and Statistician to the project, Monitoring and Evaluation of the Competitive African Cotton for Pro-Poor Growth Program ("COMPACI"), Deutsche Investitions und Entwicklungsgesellschaft GmbH (DEG), NORC. The purpose of the project was to conduct an economic impact evaluation of the "Cotton Made in Africa" initiative. For the evaluation, surveys were conducted in six countries: Benin, Burkina Faso, Côte d'Ivoire, Zambia, Ghana and Malaŵi. Under the program, cotton farmers were provided training and services so that their cotton may be certified as having been produced under the "Cotton Made in Africa" (CMiA) program. The goal of the program was to increase income and employment for cotton farmers. Dr. Caldwell constructed the evaluation and sample survey designs for all program countries. The measures of program impact were double-difference estimates based on pretest-posttest-comparison-group evaluation designs. The sample designs for the cotton project were similar to those described above for the cashew program (statistical power analysis, matching, marginal stratification, variable probabilities of selection).

February, 2009 – February 2011. Lead Statistician, Impact Evaluation of Feeder Roads Activity, Millennium Development Authority - Ghana (MiDA), NORC. The purpose of the project is to conduct an impact evaluation of the MiDA Feeder Roads Activity in eight of its 23 program districts. The evaluation will determine the impact of feeder roads improvements on input costs, product prices, and passenger fares and goods' tariffs that are associated with reduced travel time and vehicle operating cost. The primary data for the impact evaluation will consist of three market surveys, similar in scope to the Consumer Price Index (CPI) survey, examining changes in price over time in localities different distances from the improved road segments. The sample design involved matching of treatment and control localities using a "nearest neighbor" technique with a data set enhanced with GIS methods. The impact of the roads improvements will be determined employing a double-difference estimator applied to changes in prices over the next two years. Dr. Caldwell was responsible for providing advice on the strengths and weaknesses of particular evaluation designs, devising sampling strategies and designs, estimating sample sizes, drawing the sample

for data collection activities, preparing weights to apply to the price and fare observations, and assisting with analysis plans to ensure statistical robustness of results.

May 2007 – September 2013. Evaluation Expert and Statistician, Millennium Challenge Account - Honduras Program Impact Evaluation, National Opinion Research Center (NORC), Honduras. Technical advisor to provide evaluation research design and analysis services in support of an economic impact evaluation of roads-improvement and farmer-development projects funded by the Millennium Challenge Corporation in Honduras. Dr. Caldwell developed the evaluation and sample survey designs for the two projects.

For both projects, statistical power analysis was used to determine sample size. Using this approach, the sample size was determined so that the probability (power) of detecting an effect (impact) of a specified size was high. Both projects involved a "panel" sample design in which the survey was administered before and after the program intervention, i.e., the basic design was a "pretest-posttest" design. The conceptual framework for the impact analysis was the "Neyman-Rubin causal model", or "potential outcomes model," or "counterfactuals model."

For the farmer assistance project, eligible villages ("*aldeas*") were classified into sets of "matched pairs," and one member of each pair was randomly selected to receive program services. The matching was done on a number of variables believed to affect outcomes of interest, and available prior to the survey. The matching was done prior to randomized selection for treatment, to increase the precision of impact estimates and the power of tests of hypothesis about them. A probability sample of matched pairs was selected using the technique of "marginal stratification," to ensure adequate variation (spread, balance) in the design variables. The randomized-assignment-to-treatment sample was supplemented by a sample selected for treatment in the usual fashion (by the program implementer). The data analysis included development of a "two-step" model, in which the first step was a binary "selection" (propensity-score) model and the second step was an "outcome" model that included the selection probability estimated in the first step. The principal impact estimate of interest was the Average Treatment Effect (ATE), or average effect of the program intervention on an eligible farmer. The ATE was a "regression adjusted" or "covariate adjusted" double-difference estimate.

The survey design for the transportation project included selection of a probability sample of *caserios* (administrative units generally smaller than villages), where marginal stratification was once again used to assure adequate variation in variables believed to affect outcome. In particular, the selection probabilities were set to assure adequate variation in the estimated change in travel time to be caused by the program intervention (road improvements). The estimated change in travel time was calculated from a GIS road-network model that included all official roads in Honduras. The survey data were used to develop an estimate of the Partial Treatment Effect (PTE) (relationship of impact to travel-time variables) and, from the PTE, the Average Treatment Effect.

May – June 2008. Statistical Consultant, Analysis of Poverty and Social Impact of Education Sector Reforms in Mozambique, World Bank / KPMG / Manitou Incorporated. Developed the data-entry program to be used for a national sample survey of households, to assess the economic and social impact of education sector reforms. The US Bureau of the Census CSPro software system was used for this application. The questionnaire and corresponding data-entry forms were in Portuguese.

Dec 2007 – Feb 2008. Systems Integration Consultant, Governance and Economic Management Assistance Program (GEMAP), USAID / Segura Consulting, Liberia. Technical advisor to a project funded by the US Agency for International Development to develop a computer system to automate tax payments. The goal of the project is to establish a "One-Stop Shop" at the National Port, where importers can settle

their tax obligations quickly. Developed system requirements specifications and procurement documents. The system includes radio communication links among the National Port, the Ministry of Finance, and the Central Bank.

June 2007. Consultant in Information Technology and Statistics, Guinea Baseline Survey, Indefinite Quantity Contract (IQC) for Democracy and Governance Analytical, Support and Implementation Services, US Agency for International Development / Management Systems International, Guinea. Technical advisor to develop a design for a database to store data required in support of USAID's Performance Monitoring Plan (PMP) reporting and management needs, and for a statistical sample survey to collect data to be stored in the database. Advised on the database design (e.g., static Word files, static HTML files, standalone Microsoft Access database, networked database, web-based dynamic system (e.g., MS ASP.net, Adobe ColdFusion, Sun Java Server Pages, Linux operating system / Apache web server , MySQL database, PHP web page (LAMP)), selection of sample survey data-entry software (e.g., Epi Info, CSPro, Viking, SPSS), and sample survey design (a two-stage sample survey design using Census enumeration districts as primary sampling units (PSUs) was recommended, to provide data in support of a pretest-posttest comparison-group quasi-experimental design). Statistical power analysis was used to determine the survey sample sizes (number of sample PSUs, number of sample households within PSUs).

Mar – Sept 2006. Information Technology Advisor in Personnel Management Information Systems, United Nations Development Program, East Timor and Portugal. Technical advisor to advise the Government of Timor-Leste on the selection of a software developer to develop a civil-service Personnel Management Information System (PMIS). The software developer was selected and the system was successfully implemented. (In early 2012 this system was selected by UNDP as third best of all of UNDP's projects.)

Feb 2002 – April 2005. Technical Advisor in Educational Management Information Systems, Academy for Educational Development, Zambia. Technical advisor to a project funded by the US Agency for International Development, to develop an Educational Management Information System (EMIS) for the Zambia Ministry of Education. The purpose of the EMIS is to collect, store, and retrieve data (produce reports) from the Annual School Census, in support of program planning and analysis by the Ministry and donor agencies. Applications were developed using the Microsoft Access database development system, the Academy for Educational Development's EdAssist system, and the ArcView geographic information system (GIS). The project included training of host-country counterpart staff in Microsoft Access database development, maintenance and use.

Jan 1999 – Jan 2001, Director of Management Systems, Bank of Botswana, Gaborone, Botswana. Responsible for management of all information technology operations for the Bank of Botswana, Botswana's central (reserve) bank (IT vision, strategy, policy, procedures, operations, acquisition, training, staff development). The Bank's computer system was comprised of over 300 networked microcomputers running under Windows NT/95/98/2000, Novell 4.1 and UNIX operating systems. Managed a group of 16 information technology specialists to operate and support the Bank's computer hardware and software applications (network management; Microsoft Office Suite; Internet/intranet; banking operations; accounting; investment portfolio / foreign reserve management; financial data services; economic analysis; human-resources management; and asset management. Introduced modern management and software engineering practices based on standards-based quality management (ISO 9000 Quality Management standard, ISO 12207 Information Technology standard, Carnegie Mellon University Software Engineering Institute Capability Maturity Model (CMM), DOD-STD-498 Software Development and Documentation). Responsible for system development (design, implementation), procurement, training, operations and maintenance (annual budget approximately USD3 million, exclusive of staff salaries, training, and noncomputer facilities and equipment). Responsible for setting Bank's IT vision, strategy, policy, procedures, security. Supervised approximately 30 IT projects. Directed the Bank's

Year-2000 date-change ("Y2K") program, in accordance with international standards (Bank for International Settlements and US government) (no date-change problems encountered after the century date change). Directed preparation of the Bank's first disaster-recovery plan. Supervised the development of the Bank's first web page, and acquisition of the country's first "code-line clearing" system (for magnetic-ink character recognition (MICR) of bank checks). Participated in all meetings of the Bank's Executive Committee and Board of Directors; reported to the Governor and Deputy Governor.

Apr – Oct 1998. Information Technology Specialist, Educational Management Information System Design for Secondary Education Sector Development Project, Asian Development Bank / Academy for Educational Development, Bangladesh. Developed top-level requirements for the Educational Management Information System (EMIS) to be developed under a multi-year development program funded by the Asian Development Bank. Assignment included review of current systems, identification of user information needs, and identification and comparative evaluation of alternative systems.

Sep 1997 – Mar 1998. Consultant in Risk Management, Strategic Sourcing Inc., / Canada Trust Bank (now Toronto Dominion Bank), Bank Risk Management, Canada. Consultant in risk management to Canada Trust Bank. Responsible for the development of analytical models for risk management of the Bank's loan products. Developed a model for risk-based variable-rate pricing of loans, using the techniques of Generalized Lagrange Multipliers (GLM) and mathematical simulation. The methodology determines pricing strategies that are optimal with respect to the allocation of capital to the Bank's investment opportunities, taking customer, market, and policy factors into account. The computer simulation approach is used as an efficient framework for exploring alternative pricing strategies; the GLM method is used to determine pricing strategies that maximize stockholder value added (profitability) subject to constraints (on capital reserve requirements, probability of exceeding loss provisions, and other factors). The variable-rate pricing model was implemented as an easy-to-use Visual Basic microcomputer program (Windows NT, UNIX, SAS, VB5).

May 1996 – Jul 1997. Statistical Consultant to Strategic Sourcing Inc. / First Union National Bank (later Wachovia, now Wells Fargo), Statistical and Optimization Computer Models in Banking, USA. Consultant to First Union National Bank (US sixth largest bank), conducting statistical analysis to develop customer segmentation models in support of bankcard marketing initiatives. Developed optimization model for identifying profitable locations for automatic teller machines (ATMs). Used SAS statistical analysis software and ArcView 3.0 geographic information system (spatial analyst) to develop logistic regression and discriminant analysis models to identify likely customers for PC banking. Models used a wide range of economic and demographic data at the block group and ZIP-code levels (population, income, employment, sales, shopping centers, crime statistics, traffic counts, ATM locations and characteristics). Windows 95 and UNIX (Sun Solaris SPARCcenter).

Nov 1995 – May 1996. Survey Statistician, Income and Employment Survey for Ghana Trade and Investment Program, Sigma One Corporation / USAID, Ghana. As part of the US Agency for International Development's Trade and Investment Program in Ghana, Dr. Caldwell designed and analyzed the survey to estimate the employment and income associated with every $1,000 of exports in non-traditional areas. The survey was designed to produce national estimates and estimates for selected product sectors (pineapples, pineapple juice, tuna loins / canned tuna, and cashew nuts). The sampling plan involved a probability sample of 300 exporting firms selected with probabilities proportional to a measure of size (export value) without replacement. Developed the statistical software (using dBASE) to determine the sample design, select a probability sample, and compute all survey estimates and standard errors.

May – Jun 1995. Sample Survey Design and Sampling Statistician, Academy for Educational Development / USAID, Malawi. For the Malawi Ministry of Education, Dr. Caldwell developed the sample design for the Annual Primary School Survey. Previously, the annual school survey was a census of all 3,400 schools and

three million students; the amount of time and effort required to collect and process all of these data was placing a serious burden on the Planning Unit resources. The sampling plan involves a probability sample of 500 schools selected with probabilities proportional to a measure of size (the previous year's enrollment) using the Rao-Hartley-Cochran method. With the probability sampling approach, all of the information required by the Planning Unit will be available for a fraction of the effort required by the previous approach. Developed the statistical software (using dBASE) to determine the sample design, select a probability sample, and compute all survey estimates and standard errors.

Jun 1993 – Dec 1994. Personnel Management Information System Developer, Civil Servant Personnel Management Information System, Academy for Educational Development / USAID, Malawi. For the Malawi Department of Human Resources Management and Development, Dr. Caldwell designed and implemented the Malawi Civil Service Personnel Management Information System (PMIS). The system was developed using the dBASE database management information system, for use on microcomputers (standalone or networked) using the MS-DOS operating system. The system includes a variety of demographic and employment-related data for Malawian civil servants, and offers the users (personnel officers) a wide range of easy-to-use data entry and query/report capabilities. Experienced database users may generate queries and reports using SQL (Structured Query Language) commands or any of dBASE's automated query and report-generation features, but the system is designed with a powerful graphical user interface (GUI) so that a nontechnical user may generate all standard queries and reports without the need for any programming or entering of complicated commands, simply by making selections from a suite of menus. Data entry is facilitated by a series of easy-to-use data entry screens, with ample on-line help and validation of all entered data. Employee records may be displayed on the screen or printed.

The system development effort was conducted in full compliance with the DOD-STD-2167A software development standard (predecessor of today's ISO 12207 Information Technology Standard), and included the production of almost 1,000 pages of detailed system documentation, including a *System Design Document, Software Requirements Specification, Software Design Document, Software Programmer's Manual, Software Product Specification,* and *Software User's Manual*. The project included on-the-job training of members of the Department's Management Information Systems Unit (systems analysts, programmers) in systems engineering (requirements analysis, technology assessment, synthesis of alternatives, specification of evaluation criteria, selection of a preferred alternative, top-level design, detailed design (optimization), implementation, and test), the modern software engineering discipline (structured, top-down design), management information system design, dBASE, software development project management, and basic microcomputer upgrading and repair; and classroom instruction for system users (personnel officers) in use of the system for data entry and retrieval (queries and report generation).

Mar 1991 – Oct 1992. Manager of Monitoring and Evaluation, Local Development II - Provincial (LDII-P) Project, Chemonics International / USAID, Egypt. Served as manager of Monitoring and Evaluation for the USAID-funded Local Development II - Provincial (LDII-P) project, which provided technical assistance in the development and maintenance of USAID-funded infrastructure projects in Egypt (potable water, waste water, roads, buildings, rolling stock, environment, and information systems). The LDII-P project was the largest USAID local development project in the world, having funded the development of over 16,000 local-level projects. In addition to infrastructure development, a major goal of the project was to promote government decentralization and increase the capacity of local governments to plan, finance, implement, and maintain local projects. Principal activities included: (1) the design and implementation of a nationwide project monitoring survey to assess the implementation, operating, and service status of projects; (2) the development of an indicators system to assist local officials in the assessment of need for public services, the availability of services, and the identification and prioritization of local development projects; (3) the design and implementation of a governorate project monitoring system to assist governorate detection and follow-up of implementation and operational problems. On this project, Dr. Caldwell made heavy use of

automated management information system tools (dBASE, SPSS) to store, process, and retrieve data on project status and needs assessment (including continuous monitoring of project status indicators), and applied the techniques of sample survey (questionnaire development, stratified random sampling) and rapid appraisal techniques (focus group interviews) to assist end-of-project evaluation, as well as continuous monitoring of indicators. Dr. Caldwell lectured on the use of geographic information systems (GISs) in development planning, and supervised training of development planners in use of the PC-ARC/INFO GIS.

Oct 1979 – Jan 1982. Project Director / Chief of Party, Economic and Social Impact Analysis / Women in Development (ESIA/WID) Project, Vista Research Corporation / USAID / NEDA, Philippines. The purpose of this project, sponsored jointly by the Philippines National Economic and Development Authority (NEDA) and the US Agency for International Development, was to help improve the capability of the Government of the Philippines to monitor and measure economic progress, social change, and the impact of development projects, including the effects on women in their dual role as agents and beneficiaries of development. The contract provided technical services to assist the Philippines Institute of Development Studies (PIDS) to develop and validate analytical frameworks and indicators for analyzing and measuring progress and the impact of development projects on selected areas of concern; to design and field test efficient means for measuring and monitoring project progress and impact indicators; and to determine a better understanding of the mechanisms by which development projects achieve their goals. The development projects included a wide variety of substantive fields -- health, nutrition, and family planning; education; integrated agricultural production and marketing, aquaculture production, and agro-reforestation; integrated area development; feeder roads; ports; local water systems; electrification; small-scale industries, and tourism. The ESIA/WID project identified and evaluated the use of a variety of statistical design and analysis techniques to assist project impact assessment: quasi-experimental designs, sample survey, analysis of variance, multiple regression analysis, questionnaire design, indicator development. For the Philippines Ministry of Health, Dr. Caldwell developed alternative management information system (MIS) designs to support both agency operations and program monitoring. Dr. Caldwell served as chief of party and directed a team of eleven Ph.D. consultants on the ESIA/WID project.

Oct 1975 – Sep 1976. Project Director /Supervisor, Economic Policy Analysis for the Government of Haiti, JWK Intl Corp / USAID, Haiti. Under a contract funded by the US Agency for International Development, this study determined agricultural and tax policy changes that the government of Haiti could employ to increase foreign exchange and increase the income of the small farmer. The study addressed five commodities -- coffee, cotton, sisal, mangoes, and meat (major emphasis on coffee). The project included the use of rapid-assessment sample surveys to collect up-to-date data on commodity prices. A major goal of the project was the transfer of policy analysis capabilities to members of the Haitian Ministry of Agriculture. Dr. Caldwell supervised a team of four Ph.D. consultants (economists) on this project, and conducted the statistical analysis of survey data (surveys of current prices).

jgcdev20161112.doc