Joseph George Caldwell, Ph.D. (Statistics)
Consultant in Statistics, Economics, Information Technology and Artificial Intelligence
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Education...
Ph.D., Statistics, University of North Carolina at Chapel Hill, 1966
B.S., Mathematics, Carnegie-Mellon University, 1962

Consultant...
to US government agencies, state governments, corporations, and foreign governments

Director/Supervisor of projects in the areas of...
o statistical experimental design and data analysis (Stata, SAS, SPSS)
o sample survey design of major national surveys and statistical reporting systems
o computer models and information systems design (C, MS Access, Xbase, SQL)
o expert systems / geographic information systems (ArcView)
o systems and software engineering (ISO 12207)
o operations research / management science and statistics in industrial and defense applications
o monitoring and evaluation, planning and policy analysis of government programs in health, education, human services, urban problems, rural development, agriculture, tax policy analysis, and public finance
o game theory (zero-sum and non-zero-sum, constrained games, ill-conditioned problems; computer solutions of complex games)
o international development in the Philippines, Haiti, Egypt, Bangladesh, Ghana, Malawi, Botswana, Zambia, Timor-Leste and Honduras

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 projects.

Adjunct Professor of Statistics at the University of Arizona, Tucson, Arizona

Developer of technical seminars and computer program packages in sample survey design, forecasting, demographic projection, and geographic information systems

Languages: Native in English; working knowledge of Spanish and French

Summary of Experience. Dr. Caldwell's professional career in research and research management has centered on the use of modern analysis techniques to solve practical problems in government, commercial, industrial, and military applications. He has directed major technical projects; developed technical training seminars; accomplished significant research results in statistics; developed statistical, demographic, and geographic-information-system computer program packages; designed statistical reporting and management information systems; and served as professor of statistics, consultant, and manager of a contract research firm.

CAPABILITIES AND EXPERIENCE IN STATISTICS

Education. Dr. Caldwell holds a PhD degree in mathematical statistics from the University of North Carolina at Chapel Hill. In his graduate studies, he specialized in the theory of experimental design and algebraic coding theory. His doctoral dissertation advisor was Prof. R. C. Bose, regarded as the "father" of the mathematical theory of experimental design, and developer of the Bose-Chaudhuri-Hocquenghem (BCH) codes, the best known class of codes for correcting random errors in noisy communication channels. In his doctoral dissertation, Dr. Caldwell developed the best-known class of codes for correcting additive and synchronization errors in noisy communication channels.

Experience. Dr. Caldwell has over thirty years' experience as a consultant and teacher of statistics. He has provided statistical consultation in a wide variety of fields, including sample survey design and analysis; statistical analysis of data; time series analysis and forecasting; simulation and modeling of industrial and military systems; test and evaluation of communications systems; industrial quality control; process control and product improvement; and planning, policy analysis, and program evaluation in health, education, social services, and economic development.

Experience in Monitoring and Evaluation. An area of specialization in which he has applied statistical methodology is monitoring and evaluation. He developed survey designs for a number of monitoring systems and program evaluation studies in the US and foreign countries. In the US, he directed a number of national projects in program monitoring and evaluation, including the Vocational Rehabilitation Evaluation Standards Study for the US Rehabilitation Services Administration; Social Services Effectiveness Evaluation for West Virginia; the Day Care Cost Benefit Study for the US Department of Health and Human Services; Cost-Benefit Analysis of National Institute for Alcohol Abuse and Alcoholism Treatment Centers; Medicaid Standards Impact Assessment. He developed the sampling plans for several national state/federal social and economic programs, including the Sampling Manual for Utilization Review of Medicaid; the Sampling Manual for Social Services (Title XX) Reporting Requirements; and the Sampling Manual for Office of Child Support Enforcement Reporting Requirements. He developed the survey design for the Department of Housing and Urban Development Housing Market Practices Survey; the Research Design for the Urban Arterials Section of the Highway Capacity Manual; and the survey design for the Elementary and Secondary School Civil Rights Survey.

Overseas, he served as Project Director and Chief of Party for the Economic and Social Impact Analysis / Women in Development Project in the Philippines. This project provided consulting in research design (experimental design, quasi-experimental design, survey design, survey instrument design) for a broad range of development projects (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).

He served as Manager of Monitoring and Evaluation for the Local Development II – Provincial Project in Egypt. This project was the largest USAID-funded local-level rural development project in the world. On this project, which involved the funding of 16,000 local-level projects, a sample survey design was constructed to enable assessment of program impact based on a sample of about 800 projects. The projects included potable water, waste water, roads, buildings, rolling stock, environment, and information systems.

He developed the evaluation design and conducted the data analysis in support of an economic impact evaluation of roads-improvement and farmer-development projects funded by the Millennium Challenge Corporation in Honduras.

Teaching. Dr. Caldwell served as an adjunct professor of statistics at the University of Arizona. He taught the graduate course, Sampling Theory and Methods, and the undergraduate course, Statistical Methods in Management (for all students of business, public administration, and management information systems).

Technical Training. Dr. Caldwell 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:

Days 1 and 2: Sample Survey Design and Analysis (Descriptive Surveys, Design-Based Analysis for Monitoring).
Day 3: Review of Statistical Inference (review of theory needed as background for other topics).
Days 4 and 5: Causal Inference and Matching.
Days 6 and 7: Statistical Design and Analysis for Evaluation (Analytical Surveys, Model-Assisted Analysis for Impact Evaluation).
Sample Survey Design for Impact Evaluation (One-Page Summary).
Sample Survey Design for Evaluation (article, not lecture notes).
Day 8: Sample Size Determination (Precision and Power Analysis, ex ante (ex post power analysis covered in analysis)).
Day 9: Missing Data.
Day 10: Small Area Estimation.
Day 11: Continuous Multivariate Analysis.
Day 12: Time Series Analysis.
A Survey of Methods for Forecasting and Policy Analysis (article, not lecture notes).
Day 13: Demographic Analysis.

Sample Survey Design. Dr. Caldwell developed the design for many important national sample surveys (household and establishment surveys) and statistical reporting systems. He specializes in the development of analytical survey designs to collect data for model development. He developed analytical sample survey designs for impact evaluations in the US, Jamaica, Honduras, Ghana, Burkina Faso, Namibia, Benin, Malawi, Zambia, and Côte d'Ivoire, including the following:

o Farmer Training and Development Activity, Honduras (Millennium Challenge Corporation)
Transportation Project, Honduras (Millennium Challenge Corporation)
o Impact Evaluation of the Programme of Advancement through Health and Education (PATH), Jamaica (a conditional cash transfer program)
o 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)

o Community-Based Rangeland and Livestock Management Household Income and Expenditure Surveys, Namibia (Millennium Challenge Corporation)
o Conservancy Support and Indigenous Natural Products Household and Organisational Surveys, Namibia (Millennium Challenge Corporation)
o Impact Evaluation of Water Supply Activity, Ghana (Millennium Challenge Corporation)
o 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))
o 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))
o Ghana Trade and Investment Program Survey
o Malawi Annual Primary School Enrollment Survey
o National survey of local development projects in Egypt
o National Center for Health Services Research (NCHSR) Hospital Cost Data Study
o Professional Standards Review Organization (PSRO) Data Base Development Study
o Study of the Impact of National Health Insurance on Bureau of Community Health Service Users
o United States National Survey of Institutionalized Persons
o Housing and Urban Development (HUD) Housing Market Practices Survey
o Research Design for the Urban Arterials Section of the Highway Capacity Manual
o Elementary and Secondary School Civil Rights Survey

Statistical Program Monitoring Systems. He developed the sampling manuals for the following state-federal reporting systems:
o Sampling Manual for Utilization Review of Medicaid
o Sampling Manual for Social Services Reporting Requirements (Title XX)
o Sampling Manual for Office of Child Support Enforcement Reporting Requirements

Experimental Design and Quality Control. He developed statistical experimental designs for operational test and evaluation of military systems, simulation model run-sets, chemical and physical experimentation, and industrial quality control applications.

Data Analysis. He has applied statistical software to analyze sample survey data, including for a number of the sample surveys listed earlier. He is an expert in the analysis of time series data, and has analyzed data collected in accordance with statistical experimental designs. He has applied the full range of statistical analysis procedures, including sample survey analysis, multiple regression analysis, multivariate analysis of variance, components-of-variance analysis, factor analysis, and nonparametric analysis. He is experienced in the analysis of econometric data involving non-random selection (at the level of Jeffrey Wooldridge's *Econometric Analysis of Cross Section and Panel Data* 2nd ed. (MIT Press, 2010). He has much experience in the application of causal inference (causal modeling and analysis) to the design and analysis of sample surveys.

He is expert in the use of modern commercial statistical analysis software (e.g., Stata, SAS, SPSS) and the use of related microcomputer software (e.g., Microsoft Access database management system).

Research in Statistical Methodology. Dr. Caldwell served as a consultant to the US Department of Education's National Center for Education Statistics, on the Statistical Analysis Group in Education (SAGE) program. In this work, he developed a new approach to the treatment of nonresponse in longitudinal surveys. For the US Office of Naval Research, he directed the project, "Fast Algorithms for Estimation, Prediction and Control." This project was concerned with the development of an estimation methodology that could be used as an alternative to the conventional least-squares procedure, in ill-conditioned estimation problems (singularity, missing values). He has developed methodology and software to assist construction of analytical sample survey designs and the application of artificial intelligence methods (Pearl's Bayesian Networks) to assist design and analysis of analytical sample surveys.

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.htm , http://www.foundationwebsite.org/TIMESVol1TechnicalBackground.htm). The Box-Jenkins (autoregressive integrated moving average) models are useful in system identification problems, such as forecasting, control, and linear predictive coding of speech.
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.htm; 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.

For the US Department of Health and Human Services, 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. He has developed numerous "custom" programs to construct survey designs, conduct sampling, analyze survey data, determine optimal allocations, and conduct cost-benefit analysis.

Computer Models for Public Finance Management, Cost-Benefit Analysis and Tax Policy Analysis. Dr. Caldwell is author of a book on tax policy analysis (posted at http://www.foundationwebsite.org/VAT.htm) in which he presents a systematic methodology for designing tax systems. This methodology takes into account social, economic, and political constraints and objectives. In support of his work in public finance, he developed a number of computer models:

- o a financial planning model to estimate the effect of alternative tax policies in Barbados (this model incorporates Box-Jenkins (ARIMA) forecasting models)

o cost-benefit analysis models of alternative day-care systems and alcoholism treatment centers
o computer-program models to analyze alternatives to the Federal Medical Assistance Percentage (FMAP) formula, which is used to reimburse state Medicaid and Aid to Families with Dependent Children (AFDC) expenses
o computer-program models to analyze the allocation formula used by the federal government to allocate federal vocational-rehabilitation funds to the states

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.htm, and a computer program for determining sample sizes for complex surveys is posted at http://www.foundationwebsite.org/SampleSizeEstimationProgram.htm . 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.

SUMMARY OF RELATED APPLICATIONS

As mentioned, Dr. Caldwell has experience in a wide variety of applications areas. In his professional career, he has served both as a consultant specialist and as a research manager. He has directed many research projects, and supervised project teams of up to a dozen technical experts. The paragraphs that follow provide additional information on some of these applications.

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, operational test and evaluation).

- 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.

- 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, 2167A, which was the predecessor to today's international information-technology standard, ISO 12207, Software Life Cycle Processes

- 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.

Statistical Reporting Systems, Program Monitoring Systems, Management Information Systems. Dr. Caldwell developed the design for many important national sample surveys and statistical reporting systems. He specializes in the development of analytical survey designs to collect data for model development, and has developed new techniques for handling nonresponse in longitudinal surveys. Surveys were listed earlier. Reporting systems and management information systems include:

- o Zambia Education Management Information System (EMIS)
- o Malawi Personnel Management Information System (PMIS)
- o Sampling Manual for Utilization Review of Medicaid
- o Sampling Manual for Social Services (Title XX) Reporting Requirements
- o Sampling Manual for Office of Child Support Enforcement Reporting Requirements

Evaluation Research. Projects for which Dr. Caldwell developed the evaluation design or sample survey design were listed earlier. Dr. Caldwell has conducted a number of evaluation research studies, including the following:

- o Evaluation Survey of USAID Local Development Projects in Egypt
- o Social Services Effectiveness Evaluation for West Virginia
- o Day Care Cost-Benefit Study
- o Vocational Rehabilitation Evaluation Standards Study
- o Cost-Benefit Analysis of National Institute for Alcohol Abuse and Alcoholism (NIAAA) Alcoholism Treatment Centers
- o Medicaid Standards Impact Assessment

Monitoring and Evaluation. He served as Manager of Monitoring and Evaluation for the Local Development II - Provincial (LDII-P) project, the largest local development project funded by the US Agency for International Development (16,000 projects). In this role, he directed the design and analysis of sample surveys to assist monitoring and evaluation of the implementation and operational status of local infrastructure-development projects; the development of an indicators system to assist local planners in (1) assessing the need for and availability of public services (water, roads, schools, health facilities) and (2) identifying, designing, and selecting local development projects (e.g., roads, water systems, buildings); and the development of a governorate-level system to assist monitoring and follow-up of development projects.

Systems and Software Engineering; Computer Models, Systems and Applications; Management Information Systems; Database Systems. Dr. Caldwell has directed numerous software engineering projects, applying the modern principles of systems and software engineering. This approach includes 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, and has experience using international standards, including the ISO 9000 Quality Management Standard and the ISO 12207 Information Technology Standard and its predecessors (the US Department of Defense's Software Development Standard (DOD-STD-2167A and MIL-STD-498)).

He has extensive hands-on microcomputer systems development experience. He designed and implemented a 50,000-line C-language microcomputer program (an integrated geographic information system / expert system) to construct scenarios for operational tests of military systems, and personally conducted all of the software and database design and most of the programming for the information systems work in the Egypt, Malawi and Zambia applications mentioned above (dBASE, MS Access, SQL).

In a banking application, he developed a geographic information system application (ArcView GIS, SAS) to identify good locations for bank automated teller machines (ATMs). He developed simulation/optimization system for a bank to determine optimal loan pricing strategies (Microsoft Visual Basic).

His computer experience includes mainframe, mini- and microcomputer applications. Most recent work has been on MS-Windows-based microcomputer operating systems, with much experience with MS-Windows application development systems (MS Access, Visual Basic, Visual C, MS

Expressions web page development).

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).

Operations Research and Statistics in Industrial and Defense Applications. Dr. Caldwell has applied a wide variety of operations research and statistical techniques to solve practical problems in industrial and defense applications. Industrial applications include the use of simulation and modeling, experimental design, and statistical forecasting techniques to solve problems in process control, statistical quality control, demand forecasting, and economic analysis of alternative modes of production in the textile and pharmaceutical industries. Defense applications include mathematical analysis of alternative defense strategies using the theory of nonzero-sum games and Lagrange multipliers; test and evaluation of electronic communications systems and equipment using experimental design and simulation and modeling; and correlation / tracking of targets. He pioneered the use of statistical experimental design to specify runs for large-scale simulation models.

Test and Evaluation in Communications-Electronics. He served as Manager of Research and Development and Principal Scientist of the US Army Electronic Proving Ground's Electromagnetic Environmental Test Facility, which is responsible for test and evaluation of US Army communications-electronics equipment. He supervised the design and analysis of operational tests of military communications-electronics (C-E) systems, including queuing analysis of message flow, radar system evaluation, Bayesian reliability analysis, and components-of-variance analysis of voice scoring data in noisy communication channels. He directed the specification of software and hardware architectures for large-scale dynamic event-driven and real-time simulation systems.

Artificial Intelligence / Expert Systems / Geographic Information Systems. For the US Army Communications-Electronics Command (CECOM), he directed the project, "Research in Artificial Intelligence for Noncommunications Electronic Warfare Systems." This project developed an expert (rule-based) system for positioning military units and equipment, taking into account tactical doctrine, the mission of the friendly forces, the nature of the enemy threat, the location of friendly and enemy forces, and geographic features (digital terrain data). The system 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).

ADDITIONAL SKILLS AND QUALIFICATIONS

Computer Languages, Packages, and Systems. Heavy experience in applications programming in C, Visual C, Visual Basic, Microsoft Access, SQL and Fortran; experienced in application of statistical program packages, including Stata, SAS, SPSS and R. Strong microcomputer experience, including the development of graphics-based microcomputer software for geographic information systems applications. Familiar with a variety of commercial microcomputer software

(e.g., word processing, electronic spreadsheet, data base, desktop publishing, accounting). Experienced in Microsoft Office suite of products (Word, Access, Excel, PowerPoint, Expressions).

Languages. English (native); working knowledge of French and Spanish; limited German, Portuguese and Arabic (for transportation, household use).

Geographic Experience. USA, Canada, Haiti, Philippines, Egypt, Malawi, Ghana, Bangladesh, Botswana, Zambia, Timor-Leste, Guinea, Liberia, Namibia, Burkina Faso, Honduras, Jamaica, Bahamas, Barbados

Publications. Over fifty publications in the areas described above, and books on tax reform and global population (list available on request). Many articles on diverse topics (energy, environment, politics, tax reform, music, guitar, defense, religion / spirituality / philosophy, science fiction).

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)

Professional Affiliations. Institute for Management Sciences and Operations Research (INFORMS), American Statistical Association, Institute of Mathematical Statistics

Citizenship. United States, Canada

Security Clearances. TS/SCI, SI/TK, Q

Positions.
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, 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

PROJECT SUMMARIES

Dr. Caldwell's recent work has centered mainly in statistical and information-technology applications in the areas of social and economic development, evaluation and monitoring, institutional development, and management information systems development, in international-development applications. Following are summaries of several projects in these areas.

August - December, 2018. Statistical Consultant, National Opinion Research Center of the University of Chicago (NORC). Sample survey design and analysis consulting services for the USAID Kenya Project, Feed the Future Zone of Influence Survey

May – July, 2017, Economist / Statistician, EUROPE, Ltd. Consultant to the European Union (EU) -funded project, Consultancy to Undertake a Domestic Resource Mobilisation Programme Aimed at Modernising the Informal Economy in Barbados (EuropeAid/132633/C/SER/multi Lot 11, Request number 2017/384-889-1). The purpose of the project was to conduct an economic analysis of the informal economy and means by which the sector can be modernized, with an eye to increasing domestic tax revenues and decreasing the government deficit. I was responsible for the following activities / deliverables: (1) development of a Financial Simulation Model (FSM) to assess the cost/benefit characteristics of alternative tax policies; and (2) production of a comprehensive cost-benefit analysis report to determine the effectiveness of modernizing the informal sector. The FSM was a causal model that estimated the effect of making changes in three policy control variables: (1) Enforcement Strength Index; (2) Tax Burden Index; and (3) Expenditure Restraint Index. Model parameters were estimated from historical data, using autoregressive integrated moving average (ARIMA, Box-Jenkins) models based on the causal model. The FSM was used to make five-year forecasts of policy variables of interest (including the cost/benefit indicators) for a range of values of the policy control variables. The FSM was developed in Microsoft Access. A detailed FSM user's manual was developed, so that government officials could examine alternatives in addition to those considered during the course of the project. I produced three project deliverables: *(1) Financial Simulation Model for Tax Policy Analysis: User's Guide; (2) Cost-Benefit Analysis of Tax Policy Analysis Alternatives; and (3) Briefing: Financial Simulation Model for Tax Policy Analysis and Cost-Benefit Analysis (PowerPoint slides).*

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.

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 developed in Microsoft Access database development system, the Academy for Educational Development's EdAssist system, and the ArcView geographic information system (GIS).

Jan 1999 – Jan 2001. Director of Management Systems, Bank of Botswana, 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 is 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. 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.

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