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Tools Expertise

Considering only those tools, applications, methods and practices that have been used in ***production-level*** capacities, the list includes, but is not limited to:

- **Operating Systems** - RedHat Linux 6.x/7.x/FC 3-7/RHEL 3-5, CentOS 5-6, Ubuntu 10-14, MS-DOS, Windows 3.1/95/98/NT/XP, Solaris, NeXTSTEP, OPENSTEP, MacOS 6.x/7.0/X

- **Development Languages** - Node, Typescript, C, C++, Objective-C, Swift, Clojure, Ruby/JRuby, Java, Python, FORTRAN, Pascal, VB/VBScript, 16-bit ASM, PHP, ASP, csh, bash, perl (including CGI)

- **Developer Tools** - Git, GitHub, CVS, PVCS, SourceSafe, MQSeries, Sun ONE Message Queue, GNU Make, AutoDoc, JavaDoc, Glade, UML and Rational Rose, Apache

- **Databases** - CouchDB, MongoDB, Hadoop, Oracle (PL/SQL), Sybase (T-SQL), SQL Server (T-SQL), PostgreSQL (PL/pgSQL), Paradox 3.5/4.0, Access (VBScript), ODBC, JDBC

- **Networking** – TCP/IP, IPX, Novell, Windows NT/2000/XP, NFS, Cisco, NAT, Routers

Representative Projects

postgrid-node-client   **Flexbase**
    Highlights: PostGrid is a service that offers the ability to accept PDFs, HTML, templates and physically print and email the documents to recipients. As a bridge to the legal legacy world of printed documents, it's very helpful - but the straight REST endpoints makes for difficult integrations. They also have an Address lookup, verification, and autocomplete service, again with just REST endpoints. This client makes it very easy for Node/JS developers to work in a familiar system, while leveraging all the powerful features.

Design, Development, and Testing of the client. *Primary Tools: Node/JS, Typescript, Mac OS X.*

creditsafe-node-client   **Flexbase**
    Highlights: Creditsafe is a corporate credit and financial reporting service that covers most of the globe. As a resource for FinTech companies, it's very helpful - but the straight REST endpoints makes for difficult integrations. This client makes it very easy for Node/JS developers to work in a familiar system, while leveraging all the powerful features.

Design, Development, and Testing of the client. *Primary Tools: Node/JS, Typescript, Mac OS X.*

notarize-node-client   **Flexbase**
    Highlights: Notarize.com is an online notarization service, as well as an eSigning authority. With the legal documents in the Construction Industry's accounts payable/accounts receivable chain, this is essential for quick, fluid, movement of documents - but the straight REST endpoints makes for difficult integrations. This client makes it very easy for Node/JS developers to work in a familiar system, while leveraging all the powerful features.

Design, Development, and Testing of the client. *Primary Tools: Node/JS, Typescript, Mac OS X.*

Trident   **Guaranteed Rate**
        Highlights: As a part of governmental regulation changes (TRID), a system to enable
                        collaboration between the title company agents and the lender's agents needed to
                        be built. This needed to have versioning of the changes, tracking of editors, email
                        notifications, alerts, reporting and management tools.

Design, Development, and Testing of the service/application with security and a UI so that the TRID deadline (5 weeks) was met. *Primary Tools: Clojure, Mac OS X, Linux (Ubuntu 14.04-16.04), Postgres, Functional design and coding.*

Polaris   **Guaranteed Rate**
        Highlights: To enable other services to have access to the historical, versioned, loan data for
                        any number of purposes - QC (who did what, when), data mining, easy data
                        access for alerting and workflow, etc.

Design, Development, and Testing of the service/application with security and a UI so that developers in the legacy system and new system would have similar access to the company-wide data. *Primary Tools: Clojure, Mac OS X, Linux (Ubuntu 14.04-16.04), Postgres, Redis, Functional design and coding.*

Sulley   **Guaranteed Rate**
        Highlights: To enable other services to call the mortgage pricing service, Optimal Blue, a
                        service needed to be written to help transition away from the monolithic legacy
                        system.

Design, Development, and Testing of the service/application with security and a UI so that developers in the legacy system and new system would have similar access to the company-wide reference service. *Primary Tools: Clojure, Mac OS X, Linux (Ubuntu 14.04-16.04), Functional design and coding.*

The Tube   **Guaranteed Rate**
        Highlights: To enable other services to call the Fannie Mae automated underwriting service,
                        Desktop Underwriting, a persistent, historical, service needed to be written to help
                        transition away from the monolithic legacy system.

Design, Development, and Testing of the service/application with security and a UI so that developers in the legacy system and new system would have similar access to the company-wide reference service. *Primary Tools: Clojure, Mac OS X, Linux (Ubuntu 14.04-16.04), Postgres, Functional design and coding.*

Mulder   **Guaranteed Rate**
        Highlights: To enable other services to call the appraisal ordering service, LenderX, a
                        persistent, historical, service needed to be written to help transition away from the
                        monolithic legacy system.

Design, Development, and Testing of the service/application with security and a UI so that developers in the legacy system and new system would have similar access to the company-wide reference service. *Primary Tools: Clojure, Mac OS X, Linux (Ubuntu 14.04-16.04), Postgres, Functional design and coding.*

Rockford   **Guaranteed Rate**
        Highlights: To help automate the loan processing workflow with regards to the verification of
                        income, assets and employment - a paper-intensive, lengthy process at the start of
                        the loan process, a persistent, historical, service needed to be written.

Design, Development, and Testing of the service/application with security and a UI so that developers and business users would have access to the verification of assets, verification of employment, and verification of income data from FormFree and Equifax. *Primary Tools: Clojure, Mac OS X, Linux (Ubuntu 14.04-16.04), Postgres, Functional design and coding.*

Underdog   **Guaranteed Rate**
        Highlights: As part of a company-wide push to reduce the time to get to Underwriting, a
                        service needed to be built to pull loan fees from commercial sources, predict

values for taxes and other fees, and create the multi-page application package that starts the loan process. In addition to all the data collection and document preparation, there were many business rules - by county - by state that had to be considered. Finally, all this data had to be served up to the system of record for the loan data.

Design, Development, and Testing of the service/application with security and a UI so that developers and the business users could look at all parts of the application package - the pulled fees, the calculated fees, the generated documents, debugging tools for each step of the process that enabled the HelpDesk to be able to handle more support calls. *Primary Tools: Clojure, Mac OS X, Linux (Ubuntu 14.04-16.04), Postgres, Functional design and coding.*

Simon   **Guaranteed Rate**
        Highlights: To maintain a legal, historical record of the borrower's consent to eSign documents - like the Application Package, a service needed to be written to the specifications of the Compliance Group.

Design, Development, and Testing of the service/application with security and a UI so that developers and business users would have access to the consent, or lack thereof, for each borrower on each loan so that we could know at any point in time what the status of their consent was, when audits were done. *Primary Tools: Clojure, Mac OS X, Linux (Ubuntu 14.04-16.04), Postgres, Functional design and coding.*

Newsroom   **Guaranteed Rate**
        Highlights: *Total Expert*, a mortgage CRM, needed to have a service that would send it all changes to the loan data, and all changes to the contacts, so that it could accurately reflect the state of the business. Additionally, a repository for all the contacts that were in the CRM needed to be captured, and so a complete mirror of the data in the CRM was needed.

Design, Development, and Testing of the service/application with security and a UI so that developers and business users would have access to the control of the data going up, and coming down from the CRM. *Primary Tools: Clojure, Mac OS X, Linux (Ubuntu 14.04-16.04), Postgres, Functional design and coding.*

NS Toolkit   **Guaranteed Rate**
        Highlights: To enable small services to be written quickly with a highly-reliable infrastructure, a clojure library needed to be created, and maintained, which would allow all other developers to simply access resources (AWS, SQS, databases, other RESTful services) in idiomatic clojure, and therefore focus on the creation of unique business-logic and value.

Design, Development, and Testing of the library including testing and research into internal and external services. *Primary Tools: Clojure, Mac OS X, Linux (Ubuntu 14.04-16.04), Postgres, Functional design and coding.*

Bartender   **Centro**
        Highlights: The large number of Ad Servers and sources of external data to Centro got to be a significant load on the existing system, and so a new service was spun up that would be focused on doing just this one task, but in a more universal way so that additional services could easily be added, and the data sent to back-end stores.

Design, Development, and Testing of the system to access multiple external sources of client data, handle fail-overs, retries, and storage so that systems could refer to this data internally, as opposed to hitting external sources. *Primary Tools: Clojure, Mac OS X, Linux (CentOS 5), Kafka, Redis, Postgres, Functional design and coding.*

Unified-Click Stream, Disruption Detector, Finch Analytics   **Groupon**
        Highlights: The volume of data flowing through systems at Groupon got to the point that nightly jobs to aggregate, analyze, and report on data were simply too little too late, and a new generation of tools and systems were needed. Real-time - based on the

output of all client-facing systems, fast, reliable, and immediately available to all business interests in the organization. These projects are the first in that next generation of analytics.

Design, Development, and Testing of the system to process all real-time log data from all client-facing internal systems, create a unified, coherent data stream from this, calculate and store all results for historical retrieval, and serve this data to several internal groups. *Primary Tools: Clojure, Mac OS X, Linux (RHEL 5), Kafka, Storm, Redis, Postgres, Functional design and coding.*

Dark Magic   **Groupon**
Highlights: As Quantum Lead's need for ever more advanced and complex processing of the incoming demand grew, it was decided to break out that part of Quantum Lead into a separate project - Dark Magic. It was also decided that several new technologies: clojure, Storm, and Hadoop would be used in this project to establish their capabilities in production systems.

Design, Development, and Testing of the system to process demand data from internal systems, merchant data from Salesforce.com, store all calculations for historical retrieval, and serve this demand into Quantum Lead. *Primary Tools: Clojure, Mac OS X, Linux (RHEL 5), Hadoop, Storm, Functional design and coding.*

Quantum Lead   **Groupon**
Highlights: Having captured the buying habits of Groupon's customers as well as the geographical data they provide, as well as the merchant deals and capabilities, it is a natural fit to mate up the anticipated demand with the available merchants to make the sales representatives far more efficient than guessing what would benefit the merchant as well as the customer. QuantumLead is a system that does this matching and feeds the best leads back into the system for a nice, tight, feedback loop.

Design, Development, and Testing of the system to extract demand data from internal systems, merchant data from Salesforce.com and write updated info to Salesforce. *Primary Tools: Ruby, Mac OS X, Linux (RHEL 5), CouchDB, OOA&D.*

DataBusII   **PEAK6**
Highlights: Ever increasing messaging rates from OPRA, NASDAQ feeds meant a new kind of system needed to be designed and built to allow for automatic A/B arbitration, preferred side flipping in case of line outage, and downstream conflation for slow clients, so that fast clients got every message, and slow clients didn't overload, or over-burden the upstream systems.

Design, Development, and Testing of a toolkit for exchange data processing. Including modular exchange codecs, lockless queues and NBBO engine. *Primary Tools: GCC (C++), Linux (Ubuntu 10), ZeroMQ, MMD, OOA&D.*

PricingServerII   **PEAK6**
Highlights: Ever increasing data rates from exchange feeds meant a new pricing (greeks) engine needed to be designed and built to allow for faster throughput, allowing for fast consuming clients as well as slow, and adding the *what if* scenario capability not present in current systems.

Design, Development, and Testing of a pricing (greek) engine taking embedded *DataBusII* ticker plants, event-driven processing with lockless data structures to enable minimal delays in processing for both high-speed clients and slower, on-demand, clients. To minimize additional components, a request/response *what if* capability was added to give clients additional capabilities through the same interface. *Primary Tools: GCC (C++), Linux (Ubuntu 10), ZeroMQ, MMD, OOA&D.*

MMD   **PEAK6**
Highlights: SOA is fine, but service location, load-balancing, and API mismatches creates difficulties in growing an infrastructure of many diverse services. MMD, or *Magic Middle Dude*, is PEAK6's attempt at solving these issues. Using distributed erlang,

services connect to a local MMD node that replicates the services they publish, connects them to services on other nodes, balances the load of all services, and provides API conversion for websocket clients.

Development, and Testing of several local erlang services including accessing mongoDB using erlmongo. *Primary Tools: erlang, mongoDB, erlmongo, Linux (Ubuntu 10).*

Falcon   **Chicago Trading Company**
>   Highlights: Large datasets of risk and greek data for the enterprise, Fast retrieval of large
>   datasets to many web clients with minimal load on the client. Directly delivering to
>   and supporting risk managers and portfolio managers. Meeting tight deadlines and
>   delivering new features weekly.

Design, Development, Testing and Support of a very large, live, ticking data visualization and data reporting tool for risk positions. *Primary Tools: Linux (RedHat RHEL 5), Google Chrome, Google Visualization API, Java (J2EE), JavaScript, 29West, OOA&D.*

MarketMash   **UBS O'Connor**
>   Highlights: Large Systems Integration issues, C++ Server, J2EE and JMS along with RMI and
>   other middleware technologies, Directly delivering to and supporting traders,
>   Meeting Tight Deadlines and Delivering New Features Weekly

Design, Development, Testing and Support of a multi-tiered, clustered, live, ticking data visualization and reporting tool for risk positions in the organization. *Primary Tools: Linux (RedHat RHEL 3), NT/XP, C++ (GCC), Java (J2EE), MQ Series, Sun ONE Message Queue, JMS, InfoShop (see below), RMI, many third-party packages, scripting tools (sh, csh, make, etc.), OOA&D.*

InfoShop   **UBS O'Connor**
>   Highlights: Large Systems Integration issues, J2EE, CORBA, MQ Series, JMS along with
>   RMI and other middleware technologies, Directly delivering to and supporting
>   infrastructural systems, Meeting Tight Deadlines and Delivering New Features
>   Weekly

Design, Development, Testing and Support of a collector/organizer/aggregator/distributor of non-fast-tick data throughout the organization to provide to other systems at a minimal cost and maximal convenience. *Primary Tools: Linux (RedHat 7.1), Java (J2EE), CORBA, RMI, JDBC, XML, Sun ONE Message Queue, many third-party packages, scripting tools (sh, csh, perl, make, etc.), OOA&D.*

MarketData Server   **UBS O'Connor**
>   Highlights: Market Data Vendor APIs, C++ server talking to Bloomberg API, Reuters RMDS,
>   CacheStation (see below), and in-house historical data sources, Directly delivering
>   to and supporting infrastructural systems as well as user scripts/apps, Meeting
>   Tight Deadlines and Delivering New Features Weekly

Design, Development, Testing and Support of a MarketData server that allows applications in the organization to use one API (C++/Java/perl) to a single server for getting a large variety of market data. *Primary Tools: Linux (RedHat RHEL 3), C++ (GCC), several third-party APIs, scripting tools (sh, csh, perl, make, etc.), OOA&D.*

CacheStation   **UBS O'Connor**
>   Highlights: Reuters RMDS price feed conditioner and cache, Java server talking to in-house
>   API to Reuters RMDS for tick data, caching results and applying rules to get the
>   best market price for each ticker, Directly delivering to and supporting
>   infrastructural systems, Meeting Tight Deadlines and Delivering New Features
>   Weekly

Design, Development, Testing and Support of a caching price feed that allows applications in the organization to obtain a consistently good price from a Reuters data feed. *Primary Tools: Linux (RedHat RHEL 3), Java, in-house APIs, scripting tools (sh, csh, perl, make, etc.), OOA&D.*

OneCard   **BankOne**

> Highlights: Total Life-Cycle Development, Interconnection via MQSeries Middleware, Meeting Tight Deadlines, Large Java Development

Architecture, Design, Development and Testing of the back-end systems for a web-based credit card management system for the Commercial Card Services group. *Primary Tools: NT, Solaris, Java, MQSeries, SQL Server, scripting tools, OOA&D.*

CellAnalysis   **The Man from S.P.U.D.**

> Highlights: High Performance Image Processing, Web Server integration, Unique solutions and algorithms to complex problems

Architecture, Design, Development and Testing of a server-based image processing system that quantitatively identifies cancerous and non-cancerous cells in multiply stained processes for cancer screening system. *Primary Tools: Linux, Solaris, C, GTK, PostgreSQL, Apache/PHP, scripting tools, OOA&D.*

AKit   **BankOne**

> Highlights: Design Patterns, Reuse-focused Development, User-focused Deliverables, Internal Sales and Marketing

Member and Manager of a Technical Architecture Group which focused on all aspects of reuse within the Capital Markets Group - including the creation of **AKit**. These infrastructural libraries, applications and documentation saved starting groups approximately 10 man-years. *Primary Tools: NeXTSTEP, OPENSTEP, Solaris, NT, Obj-C, Sybase, scripting tools, OOA&D, Management and Sales Skills.*

CSPUD++   **The Man from S.P.U.D.**

> Highlights: Large Sparse Matrix Techniques, Topology Analysis, Simulation, Advanced OOA&D

Architecture, Design, Development and Testing of a C++-based SPICE-like circuit simulation program for traditional Electrical Engineering academic work. This included handling several issues that SPICE didn't handle well - open nodes, looped inductors at DC, and a much improved plotting system. *Primary Tools: Amiga, C++, PlPlot, OOA&D.*

Calumet Office System   **Port-to-Port Consulting**

> Highlights: Complete Business Modeling, Full life-cycle Development, Business Re-engineering

Delivered product managed everything about business operation except payroll. This included manufacture, field tank storage, shipping, order processing and rail car management for the company. *Primary Tools: Paradox 3.5/4.0, DOS/Windows, VB, Cicso MPR, Netware 3.11, Co-Session .*

BKit   **BankOne**

> Highlights: Porting from NeXTSTEP/OPENSTEP to Java, Re-useable Object Development, OOA&D

Ported much of the **AKit** to Java to facilitate faster development using tested object models. *Primary Tools: NT, Solaris, Visual Age for Java, Visual J++ .*

CKit   **UBS O'Connor**

> Highlights: Creation of core C++ utility library, Re-useable Object Development, OOA&D

Ported much of the **BKit** to C++ and added in many threading and socket capabilities missing in BKit at the time. *Primary Tools: Linux (RedHat RHEL 3), Mac OS X, C++ (GCC), OOA&D.*

North Hollow Farm   **The Man from S.P.U.D.**

> Highlights: Complete eCommerce Site, Full life-cycle Development, User Interface Development

Complete eCommerce site for business tailored to their needs including order tracking, credit card acceptance and automatic mailing. *Primary Tools: Linux, Irix, Apache, PHP, PostgreSQL, gimp, vi.*

Community Projects

Perl   www.perl.com
Found a bug in the 5.005_03 source that effected Solaris and submitted it for inclusion. Patch was incorporated.

gaim   gaim.sourceforge.net
Introduced patch for perl 5.005_03 that gets around non-patched perl versions in perl plug-in. Also patched response parser for the Yahoo IM client.

xchat   www.xchat.org
Introduced patch for perl 5.005_03 that gets around non-patched perl versions in perl plug-in.

bidwatcher   bidwatcher.sourceforge.net
Patched buffer-overflow bug in one release... added dynamically created buffers in another release... added compile-time UI options in a recent release.

DKit   github.com/drbobbeaty/DKit
Created GitHub-hosted project to share atomic and lockless container work in C++. Having been the recipient of works like boost and TBB, it seemed only fair to give back in a way that I haven't seen the need filled.

LKit   github.com/drbobbeaty/LKit
Created GitHub-hosted project to share lisp-based parser work in C++. I've used a parser like this in several projects, and placing it in Open Source means I can build on it and use it in new opportunities without having to rebuild it each time.

Potentials   github.com/drbobbeaty/Potentials
Created GitHub-hosted project to share a macOS app that solves the 2D Poisson's Equation for the electric field and potential for a 2D workspace with many different conductors, dielectrics, and configurable fixed potentials. Draws solutions on-screen. Makes use of the Accelerate framework to solve sparse matrix solutions.

CryptoQuip   github.com/drbobbeaty/CryptoQuip
Created GitHub-hosted project to share a macOS app that solves a simple substitution cypher - as used to appear in daily papers. This uses an interesting decision tree pruning algorithm to solve the puzzle in very short order.

CorePlot   code.google.com/p/core-plot/
Replaced CoreAnimation encoding problems with NSDecimals to use non-struct-based objects (NSDecimalNumer objects) and retrofitted changes into code for minimal impact.

Configulations   github.com/leongersing/configulations
Corrected merging of local config variables with the default configuration variables. The original code was completely overwriting the default config and thus not really allowing for a *minimal* local config.

Employment History

August 2024 - Present   **Now Energy Systems – Naperville, IL**
CTO, and Co-Founder working to build fish-safe, zero-carbon electricity through hydroelectric plant renovation and relicensing, as well as new Run of River plants on unpowered dams, and new sites. This is done with an eye to reduce the licensing time, and construction time to bring more power online, quickly.

December 2020 - July 2024   **Flexbase – Naperville, IL**
Principal Engineer working with start-up Founders to build Financial Services and Cash Flow solutions focused on the small to medium-sized Construction company market. Enabling easier access to credit,

better cash flow management, and drastically simplified paperwork for the accounts receivable/ accounts payable cycle.

June 2020 - December 2020   **Vodori – Chicago, IL**
Director of Engineering working with senior leadership to help empower the development group with the hard-won lessons of several decades of experience in the industry. Making the most of the Clojure-based development toolset to create stable, reliable, maintainable services in a minimum of time.

May 2018 - June 2020   **The Climate Corp – Chicago, IL**
Principal Engineer in the *Insights* team responsible for coordinating the architecture of all projects in the group with the corporate architecture. This includes web, iOS, Android, and service apps as well as covering cross-cutting concerns like internationalization and localization, and testing and testability. Representative to the corporate architecture group. As part of the shift to a Platform Group, became the Client & Partners Architect which contained many of the same duties for all Client apps at Climate.

June 2015 – April 2018   **Guaranteed Rate - Chicago, IL**
Senior Engineer in charge of leading migration from monolithic legacy app to SOA functional language-based system of small services.

January 2015 – June 2015   **Centro - Chicago, IL**
Senior Principal Engineer working with existing teams to off-load the gathering of daily Ad Server data from external services, as well as other daily metrics for offline data analytics and analysis.

July 2012 – January 2015   **Groupon - Chicago, IL**
Expert Engineer in Sales and Planning Group creating demand-merchant matching and demand processing software hooking into the Salesforce.com data as well as internal demand generation systems to enable the sales representatives to be more efficient with their time.

June 2010 – March 2012   **PEAK6 - Chicago, IL**
Senior Software Architect in Messaging and Data Feed Group creating next generation firm-wide ticker plants and greek pricing server using direct exchange data feeds, as well as in-house valuation libraries and an overall architecture emphasizing low-latency processing.

March 2009 – June 2010   **Chicago Trading Company - Chicago, IL**
Senior Developer in newly created Risk Analytics Group creating firm-wide risk and P/L applications for senior management. Duties include design, development and support of live, ticking, risk display and reporting tools.

June 2001 – March 2009   **UBS O'Connor - Chicago, IL**
Consultant/Developer on Risk Management applications for the trading floor. Duties include design, development and support of live, ticking, risk display and reporting tools delivered through a three-tier system based in Java (J2EE), CORBA, and associated datasources.

February 1996 – June 2001   **BankOne - Chicago, IL**
Vice President/Senior Systems Architect in the Commercial Banking Systems Group at BankOne, Chicago IL. Projects and activities at this position have included development, management, organization and syndication.

June 1991 - February 1996   **Port-to-Port Consulting - Indianapolis, IN**
Founding Partner, Executive Vice President, Technical Director and System Consultant, Port-to-Port Communications Corporation, Indianapolis, Indiana. Duties included advising clients on Personal Computer hardware and software purchase decisions, developing database and telecommunications applications.

August 1988 - June 1991   **Auburn University - Auburn, AL**
Assistant Professor of Electrical Engineering, Auburn University, Auburn, Alabama. Position involved teaching, research, publication, and supervision of graduate students. Total contract dollars overseen in excess of $450,000.00. Supervisor: J. David Irwin, Head, Department of Electrical Engineering.

February 1982 - Present   **The Man from S.P.U.D. – (various)**
Owner, Operator, Developer. This company has been the umbrella under which considerable academic, public domain, Open Source, and charity development and systems work has been accomplished. Projects run the gamut from circuit simulators to eCommerce web sites to talking alarm clock/calendars to decrypting software.

Education

Bachelor of Science in Electrical Engineering, May, 1982; Purdue University, West Lafayette, Indiana

Master of Science in Electrical Engineering, May, 1984; Purdue University, West Lafayette, Indiana

Doctor of Philosophy in Electrical Engineering, August, 1988; Purdue University, West Lafayette, Indiana

Publications

R. E. Beaty, J. C. Suhling, C. A. Moody, D. A. Bittle, R. W. Johnson, R. D. Butler and R. C. Jaeger, "Calibration considerations for piezoresistive-based stress sensors," *Proceedings of the Electronic Components and Technology Conference*, pp. 797-806, May 1990.

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R. E. Beaty, R. W. Johnson, J. C. Suhling, D. A. Bittle, J. C. Pope and R. C. Jaeger, "Stress measurement in electronic packaging using silicon piezoresistive sensors," *SRC TECHCON Digest*, pp. 413-416, October 1990.

D. A. Bittle, J. C. Suhling, R. E. Beaty, R. C. Jaeger and R. W. Johnson, "Piezoresistive stress sensors for structural analysis of electronic packages," *Journal of Electronic Packaging*, pp. 203-215, September 1991.

J. C. Suhling, R. E. Beaty, R. C. Jaeger and R. W. Johnson, "Piezoresistive sensors for measurement of thermally-induced stresses in microelectronics," *Proceedings of the 1991 Spring Conference of the Society for Experimental Mechanics*, pp. 683-694, Milwaukee, WI, June 10-13, 1991.

R. E. Beaty, R. C. Jaeger, J. C. Suhling, R. W. Johnson, and R. D. Butler, "Piezoresistive coefficient variation in silicon stress sensors using a four-point bending test fixture," *IEEE Trans. Components, Hybrids and Manufacturing Technology*, vol. 15, no. 5, pp. 904-914, October 1992.

D. M. Richey, R. E. Beaty and R. C. Jaeger, "Observations on low temperature NPN bipolar transistor simulations using BILOW," *Proceedings of the 1991 ECS Symposium on Low Temperature Electronic Device Operation*, pp. 75-81.

R. D. Butler and R. E. Beaty, "MOS fabrication process integrating self-aligned polysilicon gate and post-processed metal gate devices on a single die," *Proceedings of the 1991 University/Government/ Industry Microelectronics Symposium*, pp. 199-203, 1991.