

Statistical Systems Modernization

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Who and What

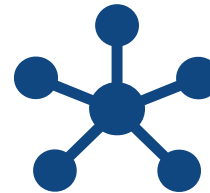


Omnicom Consulting Group, Inc.

Small firm; six technical personnel

Contracted with the Bureau of
Economic Analysis (BEA)
under U.S. Department of
Commerce

Primary builders of current
generation of BEA's modernized
systems



Modernized econometric systems – all interconnected!

US national and regional gross
domestic product (GDP)

US national and regional personal
income

US industry economic accounts

US foreign direct investment (inward
and outward)

US balance of payments



Environment



Large data volumes – efficiency is important



Long histories – continuity is important



Evolving business logic – flexibility is important



Short release cycles – support for “quick reactions” is important



Small development team – reusability is important

So, how do we get it done?



Approach

Legacy / Conventional	Modernized
Business logic embedded in code	Business logic expressed as metadata
Blackbox computations	Computations are transparent and auditable
Custom-designed isolated systems; many technologies	Common architecture and tools across all systems; fewer technologies
Changes in business methodology require code changes by programmers	Analysts change metadata, directly affecting functionality; no code changes



Metadata-based Systems



Express business logic as metadata

We use metadata to also describe **computations**!



Write business functionality-neutral code to interpret the metadata



Benefits

- Business logic can be changed **without** code changes
 - Allows for many **simultaneous** use cases
 - **Shorter** time to market and **smaller** programming team
 - **Nimble** approach that keeps up with changes in economy and ways of measuring it
- Metadata can be **programmatically** validated
- Allows for **auditability** of computations



Transparent and Auditable Computations

Computations are complex

Our modernized
systems provide
calculation audits

Reverse chains of actual computation steps

Enabled by metadata-driven architecture

Very difficult to do in a conventional system

Results in better quality estimates

Makes analysis of results **self-service** for senior managers



Architecture

Business
computations are
done directly in the
database layer,
programmed in SQL

Simpler architecture

Faster system

Smaller code footprint

Common Tool
Examples

Multi-dimensional aggregators

Formula evaluation engines

Data search, validation and auto-edit tools

Table/report generation tools



Data Depth and Breadth

System	History Start Year
U.S. GDP estimates	1929
U.S. Personal Income estimates	1929
U.S. Balance of Payments • International Transaction Account • Financial Account Detail & International Investment Positions • International Services Trade	1960 1976 1999
U.S. Foreign Direct Investment • Inward investment • Outward investment • Services trade	1992 1994 2006



Data Depth and Breadth

System	History Start Year
U.S. industry economic accounts • GDP by Industry • Input-Output Accounts • TiVA – Trade in Value Added	1997 1997 2007
U.S. regional estimates • State personal income • State GDP • County personal income • County GDP • Outdoor recreation	1929 1997 1969 2001 2012



Sample Performance Improvements

System	Improvement
U.S. GDP comprehensive update, released every 5 years	~10+ times
U.S. GDP “current” (quarterly) estimate, released monthly	~20-50 times
Regional Personal Income comprehensive update, released every 5 years	Bulk recomputation: ~5 times Incremental recomputation: ~100+ times
Direct Investment Division data disclosure control (i.e., suppressions)	From completely manual (~3 months) to mostly automated (few days)
Balance of Payments Division annual update Services Survey processing	From largely manual (~6 weeks) to automated (~3 hours)



Analyst Empowerment



Typically, there is a disconnect between analysts who **define** business logic and programmers who **implement** it



In our modernized systems, business logic is represented by **metadata**



Metadata is authored and maintained by analysts; analysts become implementors



Facilitates shared responsibility and workload



Allows for a small team of technical development staff



Summary

Our statistical systems modernization program is not just about speeding-up calculations or the use of more modern technologies and tools

Instead it is about **re-imagining** and **re-engineering** the estimate production process, and making it effective for everyone involved

Metadata approach allows for more formal, verifiable specifications

Audits allow for more calculation transparency, and easier analysis

System efficiency allows personnel **not** to spend nights working, especially during final pre-release crunch periods

Chosen architecture drastically reduces development and maintenance duration and costs

Collaborative development approach facilitates effective knowledge transfer, and ensures system longevity

Result: **Better quality estimates**



Some Technical Details



Heavy use of **tree** and **graph** data structures to model and implement computations



Novel and efficient application of **breadth-first** tree and graph algorithms suitable for SQL



Use of C#, Python and R to **extend** SQL expressive power as needed

