



Collective Work

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The idea behind *collective work* is that we're all attempting to perform individual tasks, and the ways in which we accomplish our objectives interact. Sometimes this is because we're all part of a larger project, and sometimes it's just because what we do can affect other people's plans if they know about what we've done. Sometimes, what we're attempting to do generates conflict with other people's objectives, and other times it generates opportunities. It would be great if we knew of these conflicts and opportunities – and if the Internet could tell us.

Future Scenarios

To see this idea's potential, please walk through some science fiction scenarios with me as I indulge in the New Year's tradition of imagining the future. Let's begin with a look at how such functionality could help individuals achieve their goals with ad hoc processes.

The Tour

"Indie" rock band Kriller takes it on the road with no manager or record company, just the Internet. They've organized their tour by renting from BandWiz, an Internet avatar that the band's lead singer, Jackie, called Max. In Chicago, Jackie gets a message from Max saying that the venue in Springfield has cancelled their next gig at the last minute because of cash-flow problems.

Jackie says, "Whatever; fix it." Max comes back with a report, and the band is off to St. Paul, Minnesota, to take advantage of a band cancellation there. Max has taken out insurance for the Flame-on Music Hall, chartered a plane, and contracted with a road crew to move the equipment that's just been leased in St. Paul. Notices are going out to local fans via their FaceSpace pages. Another band has leased the Krillers' current bus for a few days, and their

tour plan has been updated. After St. Paul, the Krillers will fly to a venue in Des Moines, Iowa, and then catch up with their bus and resume the originally planned tour. And each band member's cell phone will, as usual, wake them up at the right time to catch the limo that's been ordered for the airport.

The point of this story isn't to show how smart BandWhiz is about the music business but rather how much process coordination among various parties is required. Fixing the problem when part of the original plan fell through required not only coordination with new entities such as music halls, charter flights, "roadies," and limos but also changes in the plans of other people and companies who were already working with the band. The bus-leasing company was able to accommodate the change, without charging Kriller, because of a short-term need for a bus elsewhere.

The band's insurance company was able to replace two venue indemnity contracts. Ads and roadies were canceled in Springfield. The cell phone alarm schedule was modified. People and computer systems were actively notified of changes, without explicitly subscribing, and plan repairs were suggested. As the players acted on those messages, other notifications and repairs were subsequently made. Supply chains – they're not just for big companies any more.

The Manufacturer

Now, let's apply that capability to a large enterprise scenario. DellAuto manufactures custom automobiles on demand. The company acquires the automobile parts, assembles them in stages at various places around the world, and then ships them directly to the customer from wherever they're finally completed. DellAuto's core assets are automobile expertise and process coordina-

tion: it doesn't own anything other than IT facilities. All marketing is Internet-based and product service is outsourced. A chassis might be assembled in Mexico and shipped to Stuttgart, Germany, for the specialty engine maker EnginesRUs. Yet, suppose that an overall cost analysis showed that Tasmanian-based AssemNow could assemble the next 20 chassis significantly cheaper.

In that case, the parts could be rerouted from Shanghai to Tasmania. AssemNow would notify Visa-Enterprise to establish new payment, shipping, and recall conditions. DellAuto's finance department could be notified that a deposit with the Bank of Mexico was no longer required. In turn, DellAuto's treasurer could be notified that other scheduled account transfers needed to maintain cash ratios could be canceled. Despite these actions, there would be no need to notify EnginesRUs because the chassis would arrive from Tasmania on the same day they were scheduled to arrive from Mexico.

The Projects

Today, general contractors in large construction projects have bulletin boards with hundreds of notes to remind them what changes to make and who to notify regarding what to do about those changes. Now imagine computer support that could suggest which inspector to notify and how to modify the concrete-pouring schedule, for example, when an architect moves a stairwell. Imagine how such systems could reduce the cost and time of building unique skyscrapers.

The Active Internet

The commercial computer started an unexpected revolution in the 1950s. It only performed bookkeeping, but that unanticipatedly powerful concept has enabled the processing of airline reservations, credit cards, and all the other accounting functional-

ity on which modern life depended in the latter half of the 20th century. The revolutionary power of networking soon followed with the systems of the early 21st century dependent on bookkeeping and commercial Internet connectivity.

We now have a network, but we don't know how to use it to its fullest. Each of the preceding scenarios relies on a kind of *dependency* bookkeeping that we haven't yet layered on top of our network. This new layer will be active; it won't wait for us to subscribe to RSS feeds. It will watch us design the thermal controls for the new space station and send a message to inform us that changes in the docking bay's proposed design impact our current plan. It will let us know that someone has posted a Web page with the agenda of the workshop for which we have travel plans. It will cancel the next meeting on how to perform an audit because that task has just been outsourced. It will remind us that we can cancel the request to a friend for a ride because the car has been repaired sooner than expected.

Without forecasting the Internet's exact developments in the next 10 years, I can still say something about how and why such functionality will develop. Several trends will motivate the emergence of technology that will support collective work:

- Rising IT costs are being countered by increases in sophisticated Internet-based tools for individuals without much technical training, letting teenagers design social networking Web pages, for instance.
- The increased commoditization of services (including their semantics) is combining with increased demand for cheaper, personalized services such that individual services will be less valuable than the ability to network them as needed.

- Enterprises and individuals are becoming interconnected via increasingly complex processes that are difficult to change by hand-coding.

I can also say something about the best way to engineer such support. A domain-independent layer on top of the Internet should understand the general notion of change and maintaining *pareto optimality* in achieving multiple objectives. Such a layer would track general dependencies, such as the fact that some subtask is now redundant because a higher-level task has been achieved in a different way than originally planned, or that it's time to revisit some previously rejected decision because the conflict with someone else's task no longer exists.

Domain-specific process coordination layers will depend on common semantics for different fields. The combination of academic research,¹ the convergence of terms and tags (such as name, address, and job) in Web-based social networking,² and the use of common business objects in Web services will provide the basis for such semantics. We'll see an increased use of semantics in simple applications such as semantic email addressing,³ which will further increase the possibilities for the Internet to infer when you should be notified of an event.

Prediction: if you don't mind Google watching your email and your desktop, you won't mind the World Wide Wizard⁴ watching everything you do in order to make useful connections between you and other people performing their own work. (Yes, we have to avoid paperclip Bill.)

Having It Your Way

A strongly related major innovation will be to enable people to individually alter the business processes that run their lives. Don't you hate it when your ATM asks which account you'd

like to draw money from and then gives you a choice consisting of a singleton set: your checking account? Don't you hate so-called "customer-relationship management" systems? Workflows inside your company? The tyranny of your IT department?

We, as individuals, are starting to discover the power of being able to create nodes within a larger network and thus create more value.⁵ This is just the beginning of being able to customize what's available to us. Looking back at the band, Jackie can object to and change Max's plans. To examine an industrial example, let's revisit DellAuto with a mashup of Web services and Web 2.0 in mind.

Procurement officer Mia Wallace's Procurement on Demand (POD) system just alerted her of the opportunity to use the new AssemNow service for far fewer Euros than normal. However, AssemNow has some banking conditions – including establishing an account at an online bank – that interact in complex ways with the policies established by Mia's chief financial officer. Back in the day, solving this might have taken phone calls, time, and IT's reimplementation of the workflows. Back to the future: Mia's POD is now far more flexible and adaptable and can build three new workflows, on demand, using services from both companies and the bank.

Mia tries a workflow and it fails because all of the workflows must use the internal DellAuto service, which has a precondition of approval by the facilities officer to ensure that the bank has a branch office close to DellAuto headquarters. The online bank has no branches.

No problem. Mia can use the POD system's MyWeb GUI to cut and paste and create on the fly a new service that's similar to the old one except that it excludes the precondition and works only with a new category of bank – online bank – defined as a new kind of business object. POD

creates a new workflow that picks up from where the previous one failed. Mia says "make it so," and the new service partially assembles 20 of DellAuto's current orders (with an increased profit of 4 percent for which Mia is compensated) and then ships them to Stuttgart.

We're not done. Over in the finance department, Vincent Vega has himself modified several processes dealing with kinds of banks. He has developed some services that explicitly depend on the existence of bank branch offices. The network notices the relevance of Mia's new services and notifies Vince, who incorporates the online bank business object and service into a new composite service that his department is offering.

Before achieving such scenarios, our community must overcome some substantial engineering barriers, as well as a few scientific ones (such as scaling⁶ and monitoring and control of distributed processes⁷), but bits and pieces of the vision I described can be demonstrated now. See, for example, the current work in planning applications composed of services.⁸ Researchers in concurrent engineering have investigated the domain-independent dependencies necessary for an active network.⁹ Indeed, the main barriers to such visions are probably psychological and organizational.¹⁰ The world is full of people who say that we can't do something because our company doesn't work that way, but those people will retire and those companies will be subject to market forces, and things will change.

The potential for the disruptive technology of collective work over the next 10 years is enormous. Our challenge, dear colleagues, is to be a part of making it so. □

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