

# Spatial By Design: Understanding the Special Role of GIS

Michael Goodchild, Professor of Geography, University of California, Santa Barbara, presents "Spatial by Design: Understanding the Special Role of GIS" at the 2010 GeoDesign Summit.

<http://video.esri.com/watch/52/spatial-by-design-understanding-the-special-role-of-gis>

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## Video Transcription

**00:01** Now I have the big privilege to actually introduce to...the next speaker, this morning, Michael Goodchild.

**00:07** He definitely doesn't need further introduction that his name, his name has been very, for a long time, related to GIS.

**00:14** And for the last few years he has been one of the big advocates in actually trying to merge design and GIS.

**00:21** He has organized and hosted a number of events back in Santa Barbara where he's a professor.

**00:27** In sessions, brainstorming sessions, in expert sessions dealing with issues like How can we integrate design and GIS?

**00:34** And what are the concepts that sustain such integration?

**00:38** So without further delay, I would like just to welcome Michael Goodchild; please welcome with applause.

**00:50** Thanks, Juan Carlos, and thank you for the invitation to do this...

**00:53** ...and thanks to Jack and Esri for being willing to host this, this meeting.

**00:59** It's great to be on the summit; the view is tremendous.

**01:04** I was thinking of this coming in this morning, looking at Mt. San Bernardino and Mt. San Gorgonio...

**01:10** ...and thinking how wonderful it would be to be up there, to be able to see so far.

**01:14** And I think that's one of the wonderful things about a meeting like this, that we can see so far and see the vision of what might exist.

**01:24** But one of the things I have to remark is that I think the vision is enormous.

**01:29** It's as big as the horizon that one can see from the top of Mt. San Bernardino.

**01:34** And coming to grips with that is going to inevitably require us...

**01:37** ...to come down off the mountain and to descend to a more practical level.

**01:42** And I want to do that to some extent in this talk by talking about GIS and where GIS has come from...

**01:50** ...and where it currently is and how it might serve the needs of design better.

**01:56** So this is perhaps the beginning of a discussion that will go on for the next two and a half days...

**02:02** ...on exactly what we do to move this agenda forward.

**02:06** So I think this takes us in a different direction from the previous two talks...

**02:10** ...which I think provided a wonderful, motivating context for this, for this meeting.

**02:15** And I'd like now to look at the GIS issues quite specifically.

**02:20** So let me start with my interpretation of the GeoDesign vision...

**02:25** ...and this is pretty much consistent with all the material that's on the Web site...

**02:29** ...and with some of the discussions that have led up to this meeting.

**02:33** And essentially it has two parts, and I think it's important to emphasize the, the relationship between these two parts.

**02:40** One part is about input and editing and recording, and the word sketch is used very often.

**02:47** The idea that the user might be able to input a sketch of an idea, to have that input into the system, to do this collaboratively involving...

**02:59** ...and there's talk of millions of people being involved in this process.

**03:02** To do it from different kinds of devices, from very sophisticated devices and very primitive ones...

**03:08** ...to transform those sketches into features, to add them to a geodatabase...

**03:13** ...and this is very much what ArcSketch has been building towards...

**03:18** And it's also something related to, for example, Google SketchUp.

**03:22** There's technologies of this nature out there.

**03:26** But then, the other half, and to me, this is very much the other half...

**03:30** ...and that's the half which allows those sketches and ideas to be evaluated, analyzed...

**03:37** ...to use prediction to see what the consequences would be, to modify them, to improve them.

**03:42** To do this according to well-defined procedures.

**03:46** And this, of course, is something that GIS is tremendously powerful at doing.

**03:51** We have in GIS an abundance of the kinds of tools needed for that process.

**03:57** So in some ways I see that this meeting is trying to bring these two topics together.

**04:03** Bringing together the idea of interaction and sketch and, and idea creation with evaluation...

**04:10** ...based on the knowledge that's been accumulated in many disciplines.

**04:15** Now if this sounds familiar, of course, it is, and it's very much taking us back to the world of Ian McHarg...

**04:22** ...and his school at the University of Pennsylvania...

**04:25** ...because much of what McHarg was trying to do in that period was along these lines.

**04:30** It was using knowledge of meteorology, geology, hydrology, plant ecology, animal ecology, limnology, and computation...

**04:38** ...and remote sensing to build the kinds of tools that would be needed to achieve that vision.

**04:46** And so one of the things we might do, and this, in fact, is, is a slide from a presentation that Jack and, and Carl Steinitz, and I...

**04:53** ...made at the National Science Foundation in 2003.

**04:57** One of the things we might do is to try to move forward that McHarg vision...

**05:02** ...and move it into the context of 2010 and see what, in fact, what has happened to that vision.

**05:07** So let me just briefly focus on, on what has happened to that concept from the 1960s, the design with nature concept...

**05:15** ...because McHarg talked, of course, about layers, and at the time, his primary mode of operation was transparent layers...

**05:23** ...superimposed on a simple light table.

**05:25** And it's easy, of course, to see how that has led, over the years, to the layer concept that underlies GIS.

**05:33** So in many ways, what we're doing with GIS today is an implementation of that 1960s idea which, for, of course...

**05:40** ...a variety of obvious reasons McHarg wasn't able to, to implement to the kind of, of level that we can today.

**05:48** And here's a quote from a wonderful book, and I don't know if any of you have had a chance to, to read it.

**05:53** It's McHarg's autobiography. It was published by Wiley in 1996; it's called A Quest for Life.

**05:59** And he says, "For the first time, a department of landscape architecture could recruit a faculty of distinguished natural scientists..."

**06:04** ...sharing the ecological view and determined to integrate their perceptions into a holistic discipline...

**06:09** ...applied to the solution of contemporary problems."

**06:12** I think that still stands as very much what underpins why we're here.

**06:18** That same thinking, I think, is very much here today.

**06:22** What he was talking about was integrating science into action.

**06:25** Integrating the knowledge that we have in a variety of disciplines into intervention and action in the community.

**06:32** This has frequently been emulated, but very often that intervention component has been weakened.

**06:38** And Jack will remember, in 2003, when we made this presentation at National Science Foundation...

**06:45** ...and suggested the National Science Foundation might foster this kind of thinking.

**06:50** The first response we got was from one of the audience who raised his hand and said...

**06:55** ..."That's the scariest thing I've ever heard in my life."

**06:58** The idea that you would take science and try to use it in a practical context...

**07:03** ...was something quite alien to the basic scientists of...of the National Science Foundation.

**07:08** Moreover, I think the social context of this is missing.

**07:12** And it's something that today we would have to take much more seriously.

**07:15** And finally, computation and remote sensing, very primitive in the days of the 1960s, today, of course, are much more powerful.

**07:23** So if I were to try to move this forward, and this, again, is a 2003 slide, it would suggest this...

**07:29** ...that computation and remote sensing are now an inevitable part of all of this.

**07:35** David Simonet and Waldo Tobler, in fact, were advisors to Ian McHarg back in the 60s.

**07:39** Bruce McDougal was hired; he was an author of a very early text in geographic information systems.

**07:45** And technology became a source of data, an engine for computation, a means of visualization.

**07:50** And it provided a framework that was formal and replicable.

**07:54** Something that could be defended in court...

**07:56** ...something that could be shared between people because we shared an understanding of what it was trying to do.

**08:03** So 35 years later, this is 2003, has the science of intervention evolved?

**08:09** Has this evolved into something that we would recognize as the science of intervention?

**08:14** I think the answer probably is no.

**08:17** We have not achieved perhaps what, what McHarg hoped we might achieve.

**08:21** Has intervention become more scientific?

**08:23** Again, a debatable question, something we might want to debate here.

**08:27** Has the role of technology advanced?

**08:29** Yes.

**08:30** What are the components of that technology?

**08:31** Well, GIS is a very clear and recognizable component.

**08:36** And how should we update the McHarg model?

**08:39** So let me just spend a couple of minutes on that.

**08:42** The McHarg team of 2003; this is in contrast then to the McHarg team of 1965, 66; it would contain these days information scientists.

**08:51** We might call them geographic information scientists; they'd be concerned with information integration, information management...

**08:57** ...semantic interoperability, visualization of scenarios, spatial decision support systems, public participation GIS.

**09:04** All of these things would have been alien terms in the 1960s, but today would be an inevitable part of that McHarg vision.

**09:11** Moreover, we would involve the social sciences, I think, and provide a much richer social context to all of this.

**09:17** So we would involve decision scientists, concerned with uncertainty and risk.

**09:22** We'd involve cognitive scientists, concerned with the design of human-computer interaction, treating IT as an enabling technology...

**09:29** ...not imposing itself on the process.

**09:32** We'd involve social psychologists, who'd be concerned with the process of group consensus.

**09:37** So the science today underlying that McHarg model is much richer than it was in the 1960s.

**09:44** And we would intervene at, I think, a different scale.

**09:47** We would involve environmental economists.

**09:49** We'd involve political scientists in the process.

**09:52** So that's taking that McHarg concept from design with nature in the 1960s and moving it forward.

**09:59** Now let's focus on GIS, because meanwhile, GIS has been developing.

**10:03** GIS, over the past four decades, has become a technology for automated cartography, a technology for measurement...

**10:11** ...a technology for management of assets, and for scientific discovery.

**10:16** But besides those, McHarg's vision is still one of the roots of GIS.

**10:22** The idea that GIS is a technology for design is there very much in parallel with GIS as a technology for, for example, management of assets.

**10:32** But at the same time, I'd suggest that the McHarg vision has somehow got lost along the way.

**10:37** We have become busy in GIS doing things, other things, with GIS, things other than design.

**10:45** So that today, I'd suggest that seeing GIS as primarily a design technology is somewhat unusual.

**10:53** And instead, I'd, when I teach about GIS, I teach about things like managing assets...

**10:59** ...managing the assets of a utility company, for example.

**11:01** Very different from the design context of McHarg.

**11:05** So perhaps one way of seeing the business we're at here is in redressing that balance...

**11:12** ...bringing GIS back into a more design-oriented technology.

**11:17** So coming back to my two parts, I see GIS as, I see this GeoDesign context, then, as having two related parts.

**11:26** The first part is sketch and record, user interaction, sketching ideas...

**11:31** ...and the second part is evaluate, analyze, predict, model, improve.

**11:36** I struggled to find a nice, convenient acronym for the right-hand side.

**11:41** I couldn't find something that was pronounceable; I tried dropping some of the letters and substituting others.

**11:47** I'd suggest we make that one of our tasks for this, the next three days.

**11:53** I, I thought of referring to this as the yin and yang of GeoDesign, the left side, the right side, the reds and the blues.

**12:01** Somewhere there is an elegant way of expressing this...

**12:06** ...that there are two interrelated parts that we must consider in our discussions here in the next couple of days.

**12:11** So taking that right-hand side, taking the yang, if you like, what do we know about EAPMI?

**12:17** What do we know about the yang of GeoDesign?

**12:19** What we know, I think, is that ArcGIS already has many, many tools that do many of these things.

**12:27** But these tools typically are in isolation, and they're not integrated with the sketch and record side of the yin and yang.

**12:36** We have the world of spatial decision support, and I want to credit Naicong Li and her group, who've done, I think...

**12:44** ...a tremendous job in building the Redlands Institute SDSS portal...

**12:48** ...which is a wonderful resource for spatial decision support.

**12:52** But this is still a little short, I think, of what we're here to discuss, which is a much more engaged process that involves the community at large.

**13:03** SDSS still remains, I think, a technology of the expert.

**13:08** So let me just cite a few examples, because these are the tools that already exist in ArcGIS for design.

**13:15** And perhaps what they will do is illustrate what a broad canvas we're actually here to discuss.

**13:21** The horizon is tremendously broad.

**13:24** So vehicle routing and scheduling, for example, we have numerous tools in ArcLogistics for designing, bus routes, delivery routes.

**13:31** We have numerous tools for optimizing travel on networks, minimizing fuel used, minimizing time, et cetera.

**13:39** So just a couple of quick examples. Here's a ArcGIS application for the problems faced by Schindler Elevator.

**13:48** This is designing their daily workload in downtown Los Angeles.

**13:52** Optimization to minimize the amount of time spent traveling between, between sites, the sort of thing...

**13:59** ...the sort of design task that GIS can already do very well.

**14:03** Here's Sears, another client of Esri that uses the same kind of technology.

**14:10** There's one area where design already is there in ArcGIS.

**14:15** Location and allocation, finding the best locations for facilities that serve dispersed populations.

**14:21** Optimizing store sales, minimizing distances traveled, minimizing construction costs.

**14:27** All of them very much design but very much focused on infrastructure, very much focused on business.

**14:33** Very different from the kinds of examples we talked about in the first session today.

**14:37** So here, for example, this is actually a competitor; this is GE Smallworld, being used to optimize the location...

**14:43** ...design the locations of Tesco stores in part of Britain.

**14:47** Here is some work I did 30 years ago on school districting in London, Ontario, again, using GIS to optimize the design.

**14:56** And we have abundant technology for locating linear facilities, pipelines, highways, railroads.

**15:03** Optimizing environmental impacts, construction costs, operating costs.

**15:07** Wildlife corridors.

**15:09** Just a couple of examples; this is something I did recently...

**15:11** ...in the context of Native American, pre-Colombian populations in Southern California.

**15:17** This is trafficability; this is the central point is roughly the location of the Santa Ana Airport, and what it illustrates, for example...

**15:25** ...is how easy it would have been for Native Americans to have passed through the Santa Ana Gorge into the Inland Empire.

**15:34** We can do this kind of thing with existing tools.

**15:37** Here's a wonderful example of using GIS for optimum design.

**15:42** These are the wildlife bridges over the Trans Canada Highway in Banff National Park.

**15:47** Very successful as ways of allowing wildlife populations to cross the four-lane highway without accident.

**15:55** And we've done a lot of work using GIS for land-use modeling.

**15:59** So, for example, we have worked on predicting urban growth, predicting land-use transitions.

**16:05** We have models that users can use to control parameters, control in, in, initial conditions, but expert users, that is...

**16:13** ...experts who understand the models and understand how they work.

**16:16** So here, for example, is the work of Keith Clark, my colleague at Santa Barbara...

**16:20** ...forecasting the development of the Santa Barbara area under various growth scenarios.

**16:26** A simple model, it's actually a cellular [unintelligible] that is based on simple variables...

**16:32** ...such as existing land use, elevation, slope, and access to transport.

**16:39** Here's a model from the, from British Columbia, from the lower Fraser Basin, the quest model.

**16:45** This is much more geared towards public participation because the public is able to modify the parameters...

**16:51** ...through a simple interface and then see the consequences in terms of predicting growth in the, in the Fraser Basin.

**16:58** So these are things we can do.

**17:00** But to come back to my earlier point; these are not integrated with the other side of the yin and yang.

**17:06** They're not integrated with sketch and record.

**17:08** They don't allow the non-expert user to participate in the design process.

**17:13** What they do, however, is something that I think is very much a part of this discussion and something that, in many ways...

**17:21** ...captures what I visualize as the future of this technology.

**17:25** What I would like is to be able to bring up a map such as this, to design by introducing sketched features...

**17:34** ...and then to press a button and have that button evaluate or predict or improve on my design...

**17:42** ...by bringing the strength of GIS and all the models that we have available...

**17:46** ...and all the scientific knowledge that we have to assess, model, and analyze my suggested solution.

**17:54** That's something that I think is all too often missing.

**17:56** It's something that we can conceive of doing given the strength of GIS in the background.

**18:02** So that's why I think this yin and yang is a very appropriate way to frame this discussion and to think about it.

**18:09** Just a, a few other topics I should mention briefly.

**18:12** One is devices, because I think part of this vision is that these solutions would be interactive; this would be an interactive technology.

**18:21** It might use physical analogs, and I'm sure we will see over the next couple of days, physical analogs including that table.

**18:30** I know, for example, the work of Leo DeSilva's group, which has involved the concept of...

**18:35** ...of moving clay in a virtual environment...

**18:39** ...actually shifting clay around, shifting various kinds of physical analogs around in a virtual environment.

**18:48** We can think of this as high end and low end; we can think of the high end as being virtual cave environments or tables.

**18:55** We can think of the low end as being nothing more than cell phones and Wii terminals.

**19:00** So a huge variety of possible devices might be used to implement this kind of vision.

**19:05** So here's just one example; this is actually the work of Antonio Camara's group in the University of Lisbon...

**19:11** ...and this involves a table, and virtual features are being moved on the table.

**19:16** To, to go back to my vision, what I would like to see in a table like this is a set of buttons that I can press to bring all of the tools...

**19:25** ...and all of the power of GIS and scientific knowledge to bear on assessing, analyzing, and modeling my proposed solution.

**19:34** And then another element that I'd suggest is something we have to include in this discussion is the wisdom of the crowd.

**19:40** We have to think about this not just in then, in the sense of the top-down process involving experts...

**19:46** ...but also a bottom-up process involving millions of potential stakeholders.

**19:51** And that's something that these days, we can achieve.

**19:54** We have the crowd sourcing technologies, we have Web 2.0, we have mobile phones.

**20:01** This is the world of neogeography, and if you haven't come across that term before, it's a wonderful term.

**20:07** It refers to the ability of the average citizen these days to do many of the things...

**20:11** ...that geographers have traditionally regarded as their professional expertise.

**20:16** It makes me a paleogeographer, which is a wonderful thing to think about.

**20:22** I don't know if you've seen anything of the MIT, the, the winning...

**20:27** ...the competition that DARPA ran a couple of weeks ago that MIT won...

**20:32** ...which involved crowd sourcing to solve the problem of finding a series of red balloons located across the United States.

**20:40** And MIT's solution was simply to very rapidly recruit a network of people, a network observ...

**20:46** ...of observers across the country and to use the crowd to solve the problem.

**20:51** It's a very elegant kind of solution.

**20:53** I'd suggest that's part of what we have to talk about here...

**20:56** ...the possibility that today's technology can include a vast array of potential stakeholders.

**21:03** So to try to pull this together, let me, let me ask the question Where do we stand?

**21:07** And I'd suggest that we have currently some of the tools needed to achieve this vision.

**21:14** Some of them are integrated in GIS, but they're generally scattered.

**21:19** And generally they're not integrated with the other side of the equation, with sketch, with crowd sourcing.

**21:25** They're not integrated with the part, kinds of participation that we can now achieve through interactive devices.

**21:32** And what's more, the set is not complete; there is some major holes, major gaps in the set.

**21:38** So I think these are the kinds of questions we ought to be thinking about.

**21:42** We have some devices, but the interoperability between those devices is very limited.

**21:48** People who have worked with things like tables have typically developed their own software unique to that device...

**21:54** ...and have not integrated across a variety of different devices.

**21:57** And we have very few studies of how users react to these kinds of technologies...

**22:02** ...what kinds of design criteria they want to see implemented to make the interaction as, as easy as possible.

**22:09** So what needs to be done?

**22:10** Here's my suggested set of ideas for what we can talk about in more detail over the next couple of days.

**22:17** Number one, I think it's important that we try to map out all of the use cases.

**22:22** It's easy to become focused on some limited problems of design.

**22:28** And I think we need to keep our horizon very wide and try to think of all the different kinds of design problems that we will face...

**22:37** ...particularly in the context of Tom Fischer's talk, which raised a host of design issues.

**22:43** And somehow I think we need to enumerate what those are.

**22:47** Number two, I think it would be impossible to approach this problem holistically.

**22:53** The set of possible problems is so large...

**22:56** ...it will be very difficult to be wise enough to design something to respond to all of them.

**23:01** So I'd suggest the strategy we need to use is a strategy of rapid prototyping.

**23:06** We need to select a few problems and prototype what our vision means for those problems.

**23:13** We need also, I think, to integrate new kinds of user interaction; this means sketch, this means new kinds of devices...

**23:19** ...and this means Web 2.0 kinds of concepts.

**23:23** We need to learn from those prototypes, and I'd suggest we need to learn from those prototypes...

**23:27** ...particularly in the sense of the reactions of users.

**23:31** It's the ability of users to interact with these technologies...

**23:35** ...which is going to determine ultimately whether they get adopted and whether they get used.

**23:39** So that has to be an important part of the agenda.

**23:43** And out of this, I'd suggest that we can hope that a comprehensive solution would emerge.

**23:50** I don't think a comprehensive solution should be designed top-down; I think it's too early to see the wood for the trees.

**23:57** So, thank you very much for your attention.