Using Revit to Design for Social Distancing: New Tools and How to Use Them

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Learning Objectives

- Learn how to use the latest "path of travel" tools in Revit to safely layout out route designs.
- Learn how to design spatial layouts that take into account social distancing of different values in different buildings.
- Discover the fundamental principles of the spatial relationships of passageways and doors to ensure safe distancing.
- Learn how to transfer your Revit model into a people-movement simulation package to simulate pedestrian flow.

Description

Organizations around the world have been tasked with reshaping facilities and operations to enable social distancing since the outbreak of COVID-19. To support the design team, building owners, and facilities managers, we are committed to developing new tools in Revit software and showing how they can be used in practice with other simulation tools. This session will combine demonstrations of the latest tools in Revit with good practices learned from collaboration with industrial partners to ensure that buildings will have the capacity to support social distancing and maximize life safety. Subjects that we'll cover include design principles (core parameters, route planning, design pitfalls) and sample use cases (office, retail, school). We'll lay out the core principles of design and demonstrate their application with Revit (and people-movement simulation software) in the context of real-world design challenges.

Speaker(s)

Pete Thompson is a Senior Principal Engineer in the Revit development team. He has 28 years in dynamic simulation of building performance, evacuation modelling, pedestrian dynamics, and several other forms of dynamic physics analysis. For his PhD, he wrote the pedestrian movement model Simulex, and maintains an active role in research for pedestrian movement through collaboration with Lund University.

Minjie Wang is a Senior Product Owner in the Revit development team. She has 12 years working experience in Autodesk Revit product design and team management, and is now focusing on optimizing the Revit documentation and analysis to help architects, engineers and BIM managers to work efficiently.

Introducing the People Flow Toolkit

The new People Flow toolkit is intended to help designers to meet some of the challenges of implementing measures for social distancing. It should be useful to address some of the new geometry problems and help understand the ways to better solutions, using purpose-built tools, within Revit. This instructional demo includes additional background information about the ways to measure social distance and some of the key scientific & geometric aspects behind social distancing, to help you apply the design principles as an overall strategy rather than simply how to use the technical features.

The toolkit is available as an add-in to install to Revit and is available via our accounts site or via the Autodesk Desktop App. Additional information is also available on our technology preview blog.

Background – the science and measurement of "social distance"

The best-known use of the term "social distance" came from Edward Hall's work in the early 60s on "proxemics". Proxemics is the analysis of space, inter-personal space and how it applies to people.

Hall identified 4 spatial zones: intimate space, personal space, social space and public space. These zones relate to comfort and how incursion into the space effects how people feel, and then move. The "social distance" is in the distance zone where one person's movement affects another, but they do not feel uncomfortable.

The range of social distance that is observed occurring naturally between people is between generally 4 feet to 12 feet in North America, and it's really important to understand that **now** we are trying to fix it to be 6 feet as a minimum, for public safety.

That's the fundamental shift; the new "social distance" is set to a minimum of 6 feet, rather than just observing a natural inter-person spacing, which is normally affected by culture, task, and levels of stress
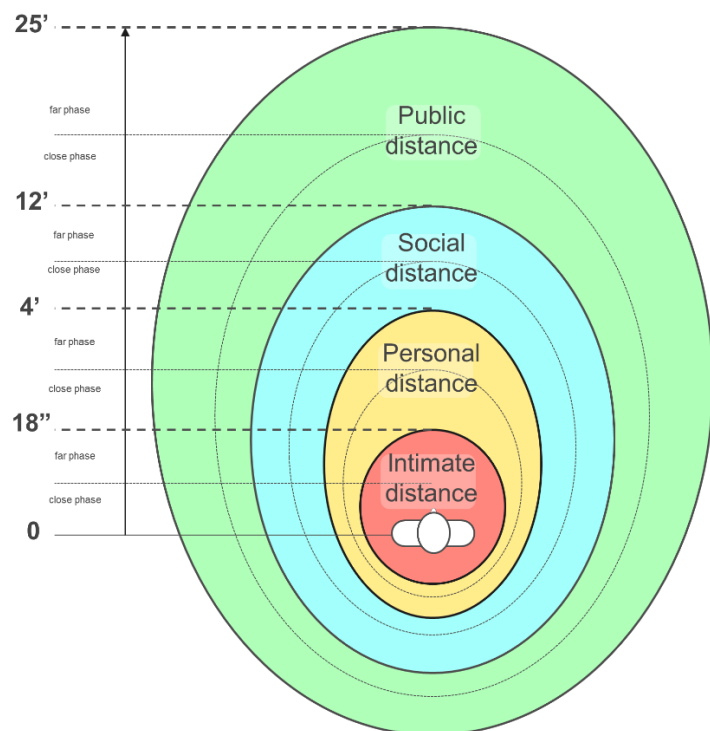

FIGURE 1: THE SPATIAL ZONES OF PROXEMICS
(sketched from Edward Hall, 1966, "The Hidden Dimension")

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Leading on from Hall's work, John Fruin published the most famous pedestrian planning book of the 20th century: "Pedestrian Planning and Design". This publication was based on many research studies in multiple locations and scenarios in North America and referring to other countries including the UK in the 1950s and 1960s. This publication became the basis for design in the New York Subway initially, but many other mass transport facilities across the world later, and it is still referred to very often in the field of pedestrian planning. The most useful point of reference here is that it discretely labels space as different levels of spatial service, which we are now trying to enforce. Implementing a social distance of 6 feet automatically enforces the most free-moving level of service: "Level of Service A".
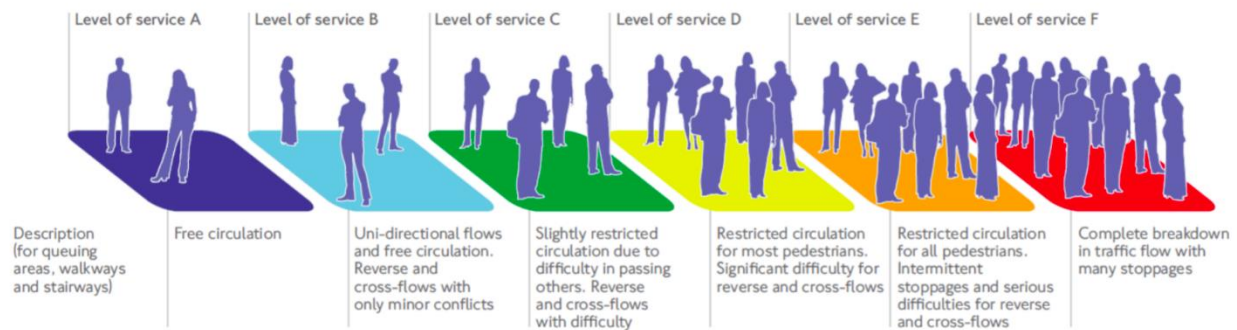

FIGURE 2: Fruin's levels of service for walkways, illustration from "Station planning standards and guidelines", Transport for London, 2012.

Why does social distance specifically matter?

FIGURE 3: snapshots of guidance, referenced from public information web pages.

When we look at the reason for physical distancing, we can look at 3 sources as good examples:

1. The US Center for Disease Control – which states that COVID spreads mostly between people who are less than 6 feet apart

2. The UK Government which evaluated that just 1m distance gave a relative risk of transmission of 2 – 10 times higher than 2 metres

3. The World Health Organization recommends at least 1 metre and wearing a face mask.

Each reference gives a different value for social distance, but ultimately, social distancing is a way of reducing risk, and should be in addition to other measures put in place to reduce viral transmission, under local guidelines. You should take care, before implementing a new design, to check what the applicable value is for your locale and ensure that you meet those requirements.

What value do I use, and how do I measure social distance?

FIGURE 4: public information images from different regions & organizations around the world.
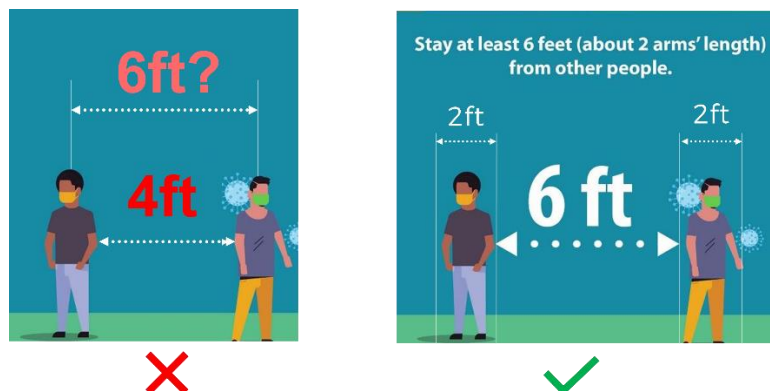

FIGURE 5: simple illustrating the correct and incorrect ways of measuring the social distance, "in-between" people.

There are many ways to measure the distance between people: nose to nose, foot to foot, center to center. The World Health Organization recommends distance between points of contact: the distance in-between people, not center to center (as is often mistakenly implemented). The values vary in different areas around the world, as shown in the public information poster images, but they all show the distance in-between people, or "nearest point to nearest point". We've often seen designers measure from center to center points when looking at markings on plans, without personal body space being accounted for, but this gives an actual social distance which is about 2 feet less than what should be in. The two images in Figure 5 show both the right way, the wrong way, annotating images from a CDC poster. Incidentally, the 2-feet allowance that we have annotated and shown is derived from Fruin's "design" body dimensions, as used for New York Subway design.

Marking out social distance on the ground

So, now we know the right way to measure social distance, lets illustrate the most common design error, as shown in Figure 6.
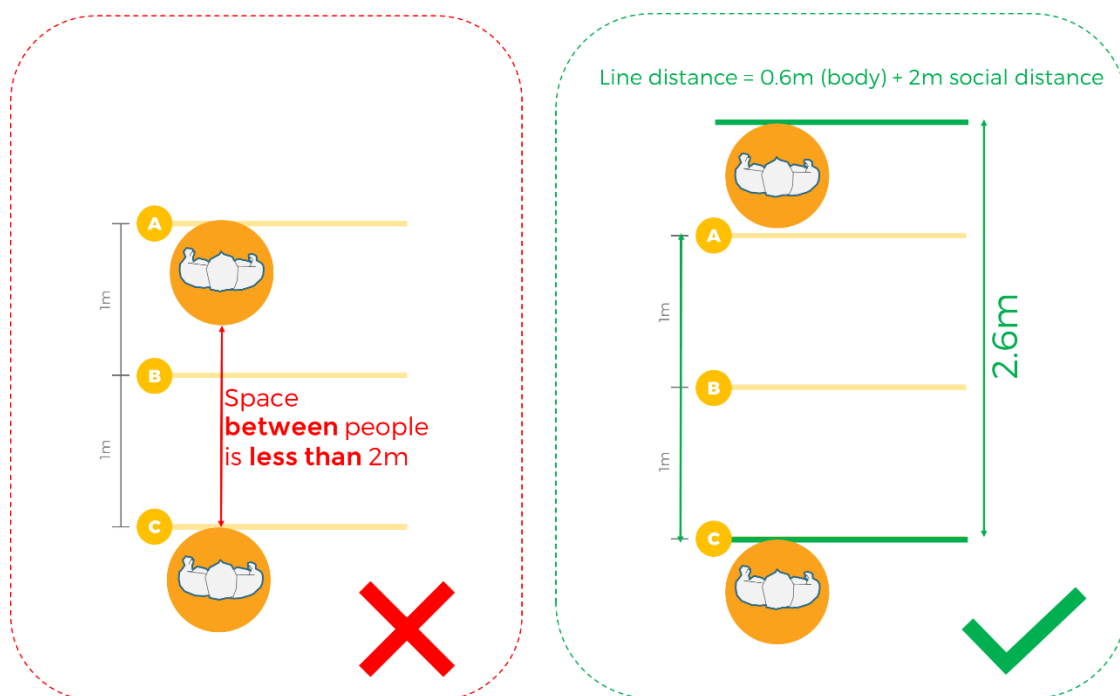

FIGURE 6: Examples of 2m social distance for queue lines marked on the ground.

On the left, the planner, aiming for a UK standard ("outside-space") value of 2m social distance has marked that value of 2m exactly on the ground for queue lines. However, when people actually stand on the ground, and maybe turn around in the little spatial bubble, then the distance becomes much less – maybe 1.4 meters. They should be marking 2 meters plus an allowance for the body space, taking the length between queuing lines to 2.6 meters. As a result, you will see the ability to custom-set the social distance values in the tools in the People Flow Toolkit – reflecting different regions and dimensions.

The use of grids and partitions

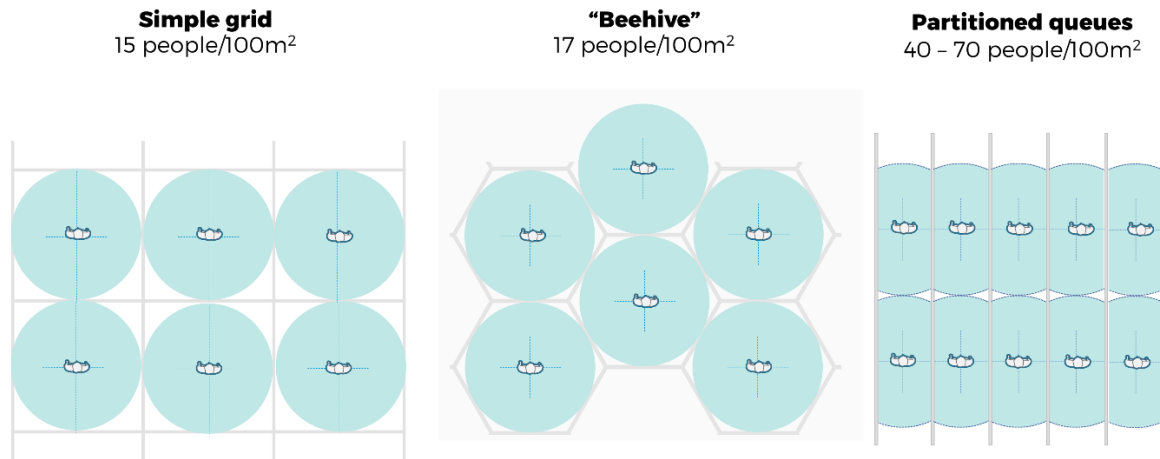| **Simple grid** 15 people/100m²	**"Beehive"** 17 people/100m²	**Partitioned queues** 40 – 70 people/100m²

FIGURE 7: Occupant densities for different grid and partition layouts with 2m social distance.

Many designers just default to using a simple square grid to achieve social distance, but it's not the most spatially efficient over large areas. A beehive-type layout is 12 – 15% more efficient if you have enough space and flexibility to achieve it. However, you can achieve a half or a third of the space more, per person, if you use partitions. That's why you see partitions in many places now. Clear partitions are much better because when you emerge from the partitions, you can avoid getting too close to other people in different lanes. Therefore, we prioritized tools to help design with both square grids and hexagonal grids for spaces. Partitions can be designed with existing wall and family tools in Revit.

Consider Lanes

FIGURE 8: Example plan view of occupant flow in lanes with and without 2m social distancing reproduced from illustration created by Movement Strategies(now GHD).

The "new normal" for pedestrian planning is to start with the assumption that lanes and one-way flow are much more manageable and efficient; ultimately they are a much safer way to achieve social distancing. Be aware that, therefore, your flow rates through doors may drop by as much as 75% as a result of one person at a time, with more space between them. That's why we prioritized tools to help with one-way flow design for Revit.

The main features within Revit

The People Flow Toolkit extends Revit's Path of Travel toolset

Greater functionality around Path of travel analysis has been the focus for Revit development, with the first release of the Path of Travel tool in Revit 2020. The intent is to provide Revit users and Revit developers with smarter, faster ways to design and automate wayfinding and egress and ingress calculations, with access to tools in Revit and through the Revit API. In Revit 2020.2, waypoints were introduced, allowing a designer to adapt, manipulate, and recalculate paths for multi-point paths of travel, improving the flexibility of the tool, and enabling specific implementations of travel distance geometry rules, defined in the building codes.

The People Flow Toolkit includes 4 new tools

With the People Flow Toolkit, we're expanding functionality to address the challenges of designing for physical distancing due to COVID-19. The plug-in includes 4 tools:

Multiple Paths - Multiple routes between points for a path of travel are created simultaneously with a minimum separation distance.

One Way Indicator - Places a family in the model to indicate the direction of travel. The family is respected by the path of travel calculations.

People Content - Places a family in the model to represent occupancy of a space and block path of travel lines.

Spatial Grid - Places a room-based grid overlay to visualize spatial distancing in the room.

Multiple Paths

In the main released version of Revit, the Path of Travel calculates the shortest route by defining the start and end points. Now, we need to consider "efficiency" and "Safety", in the design. When the shortest route intersects a congested area, another alternative route should be provided.

Identify the starting and end point, Path of Travel tools will provide multiple routes by bypassing the obstacles. So that designers can optimize the space design based on the analysis result.

1. Define the start point.
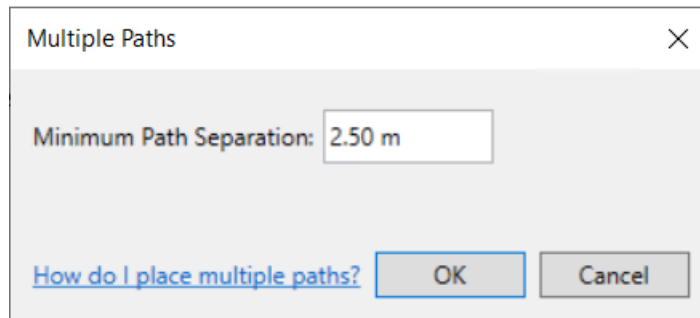2. Define the minimum path separation.

FIGURE 9a: Minimum path separation

3. Define the end point
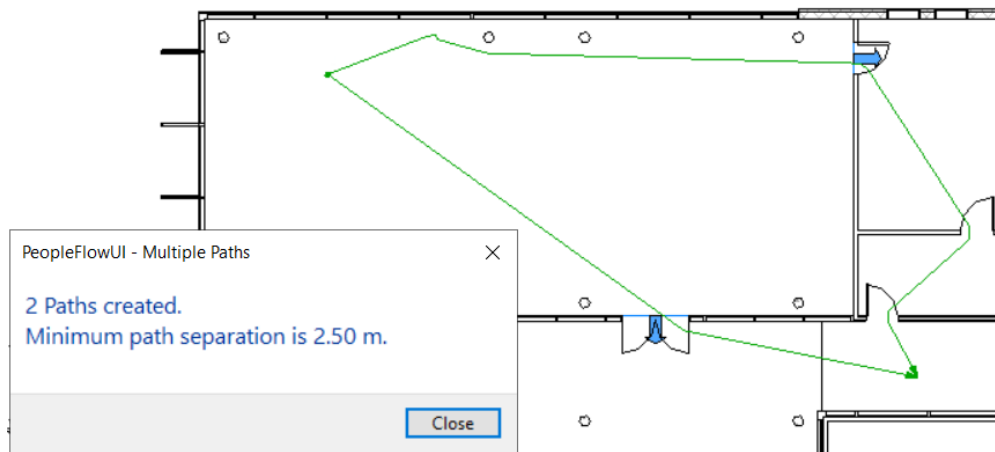4. The tool will generate multiple paths.

FIGURE 9b: Multiple pathways

One Way Indicator
1. Clicking the "One Way Indicator" button, Revit will automatically load and place the one-way indicator family into your current project. Place instances or multiple instances of the family in the building space. "Multiple Paths" from the People Flow toolkit or original "Path of Travel" will consider the one-way indicator in the calculation. The route(s) generated won't violate the one-way direction indicator. If the direction of the one-way indicator is changed, the path of travel will be updated to reflect the change of design intent.
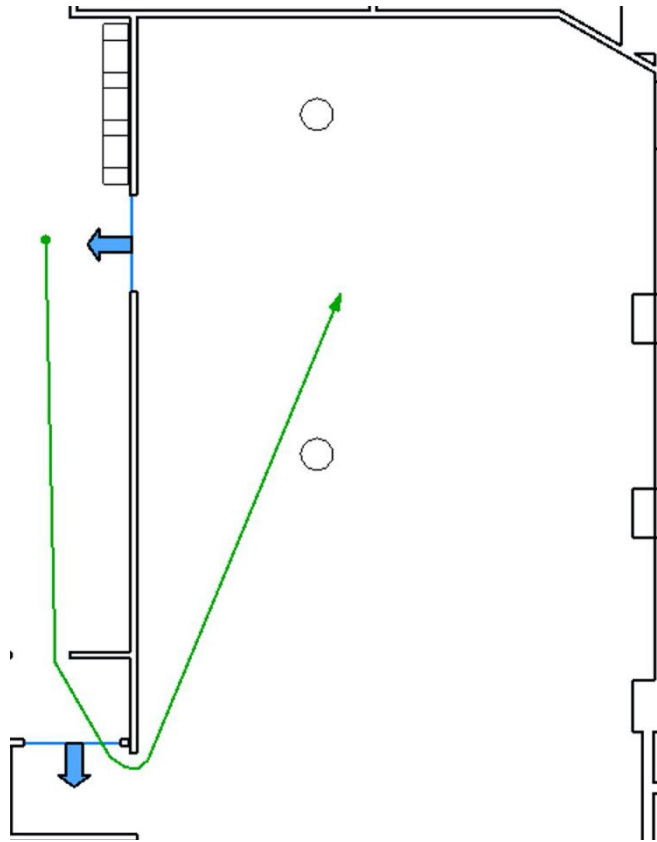
FIGURE 10: One-way indicator

2. The one-way indicator content can be embedded to another family as a nested family. The host family will inherit the same direction in the path of travel calculation. Note: the one-way indicator family should be set as "Shared" in the nested family.
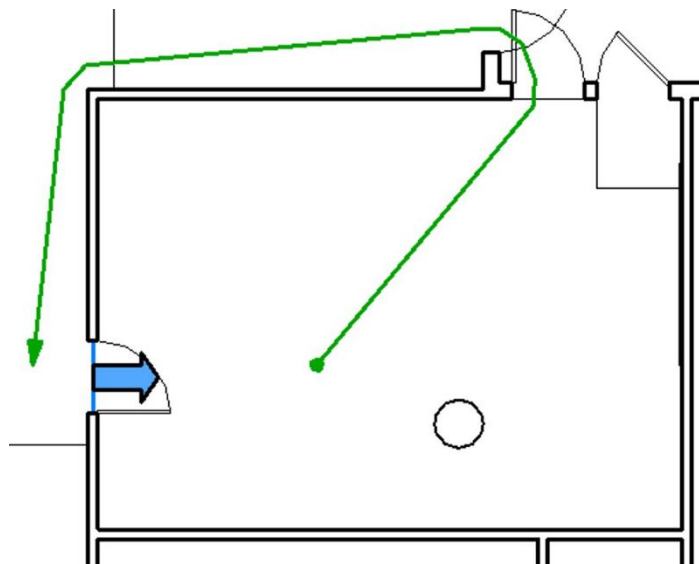

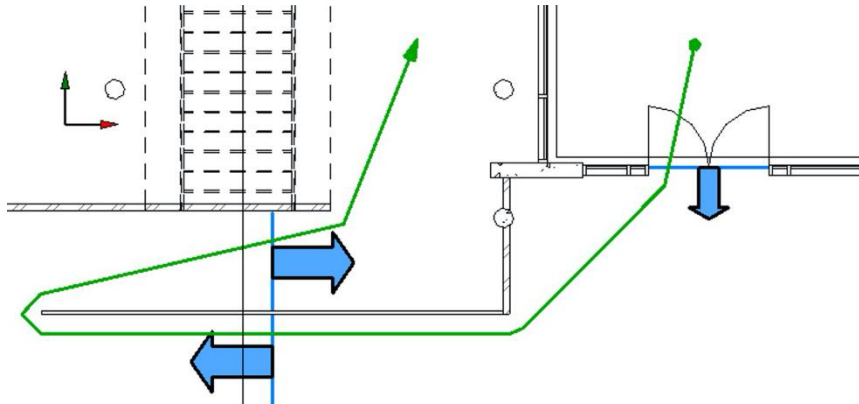FIGURE 11: Door family with one-way indicator nested family

FIGURE 12: Generic model family with 2 one-way indicator nested families.

People Content

Use the generic model family to create a physical distance indicator in nested family, the person content will be treated as a "Blocker" in the Path of Travel calculations during route analysis.

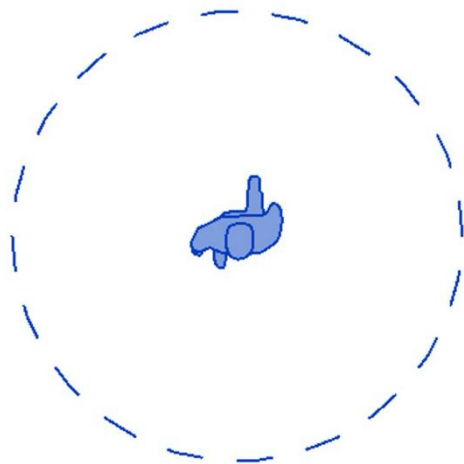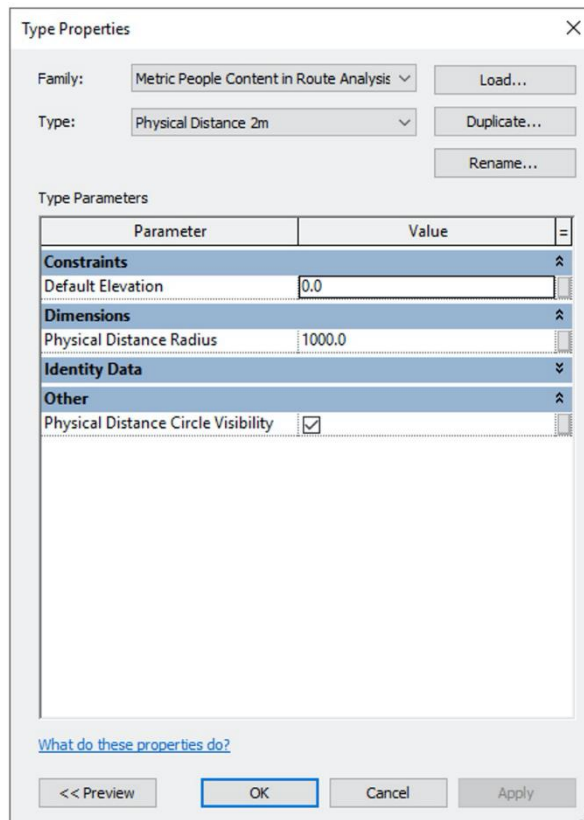You can change the value of the physical distance parameter and set the distance indicator visibility.


FIGURE 13: setting the physical distance value

Spatial Grids

1. Choose the room you want to apply the physical distance grid pattern. Choose the pattern (square or hexagon), and then define the physical distance value needed for the design. The grid pattern will be applied. Remember to add an allowance for body space if you are planning to place people, but this may be different for furniture etc. which is why we have not set a default other than a basic one.
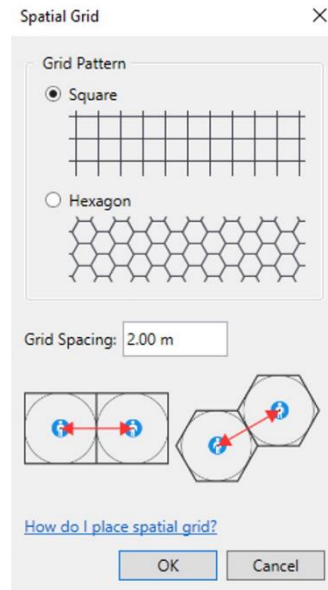
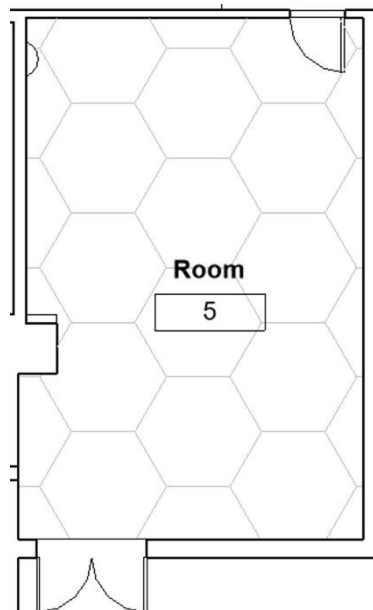2. Easily move or align these patterns to fit properly within the room.

FIGURE 14: setting spatial grid parameters.

How to install the People Flow Toolkit

The People Flow Toolkit is available via your accounts.autodesk.com site or via the Autodesk Desktop App. Once installed, the toolkit is accessed from the "Analyze" menu and appears as a palette next to "Route Analysis" called "People Flow Toolkit" From the palette.
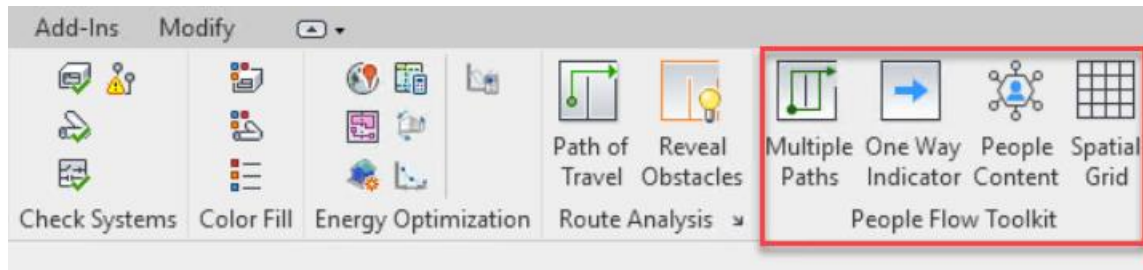

FIGURE 15: The Analyze ribbon when the People Flow Toolkit is installed.

Design principles to keep in mind

Choose which grid or partitioning works best

To help with the grid layout, use the new grid pattern placement tool for a room space. Ensure that you set the right dimension and pattern type – you're almost certain to need to change the grid spacing from the default value to include body size and the social distance which applies for the guidance in your location. The right grid for you will depend on the main plan layout of the building envelope. You can move, snap and center your families (for desks, chairs, people etc.) for your grid cells. You can then hide the grid again when you want.
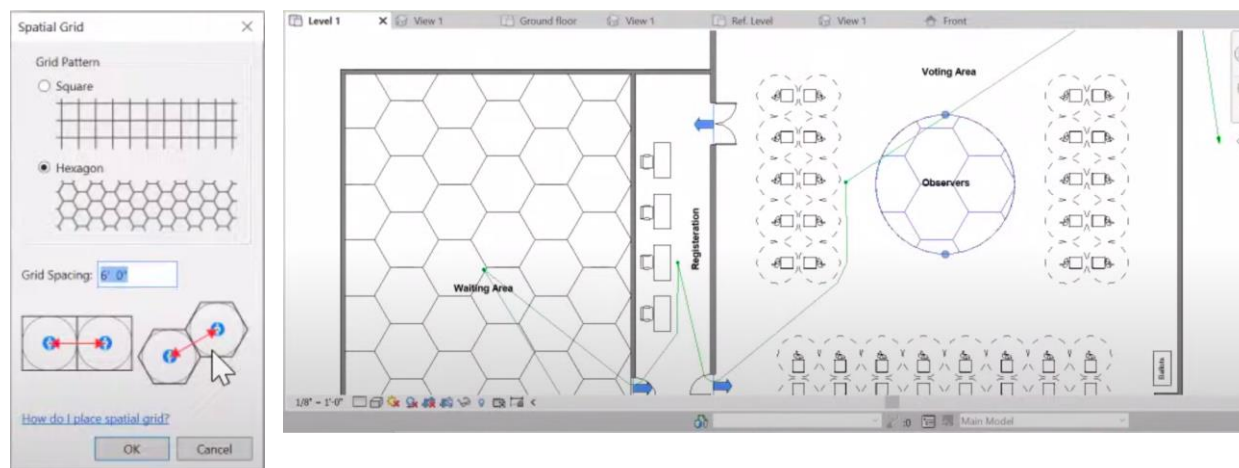

FIGURE 16: Sample screen images of grid dimensions and partitions.

Use one-way flow wherever possible

One-way flow should be your new go-to approach to designing pathways and passageways in your building. Simply because, if you try to use existing door layouts, you really won't be able to properly maintain social distancing. When one person wants to enter the door, against the main flow, then the main flow has to stop and pause 6 feet back from the door (for 6' social distancing). All traffic stops and waits, creating longer queues and movement times. Even this works only if you have 10 feet wide corridors either side of the door. Stop and go systems are best avoided and hard to manage, so you should designate a system of one-way doors wherever possible.
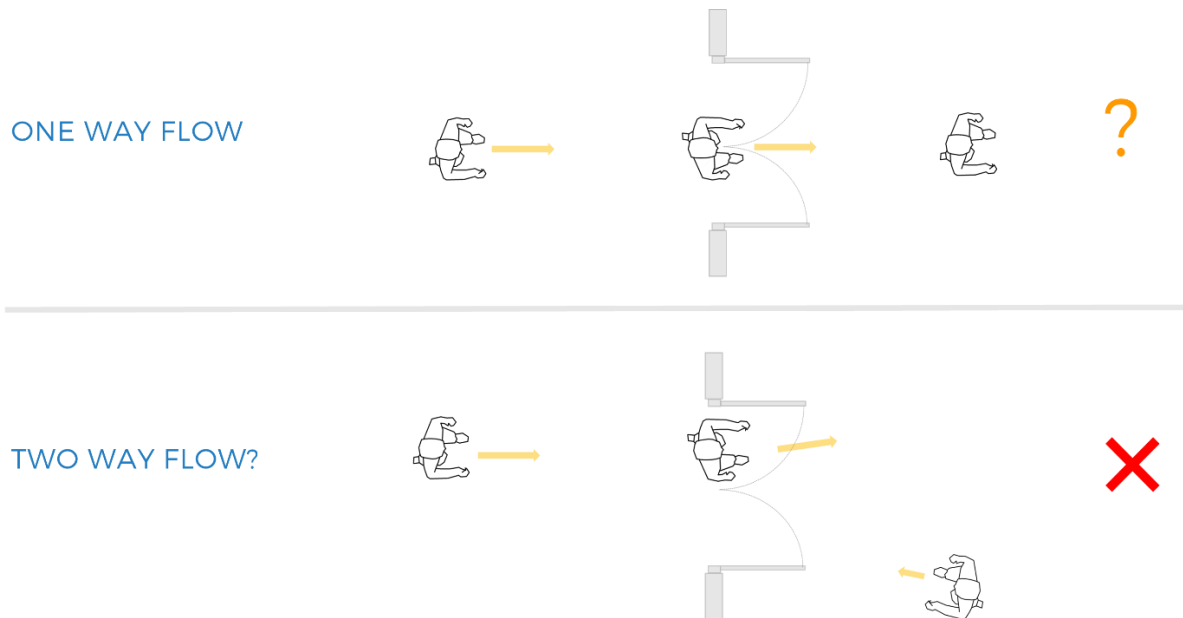
ONE WAY FLOW

TWO WAY FLOW?

FIGURE 17: problem with attempting two-way flow through a door, with social distancing

Don't forget circulation space

When placing grids, in existing spaces, like a school classroom, it's all too easy to forget the space needed for circulation. Some people need to move at different times from others, and using an adjacent-squares grid means that it's not possible to avoid breaking social distancing rules.

You could use partitions or central aisles or consider other approaches but when planning routes, please don't forget the general circulation for different people moving at different times. In the example shown in Figure 18, a new spatial grid is adopted for desks, but no allowance is made for circulation, so when a pupil needs to leave the room they can only do so by making an incursion into the social space of every other pupil along the way until they get to the door.
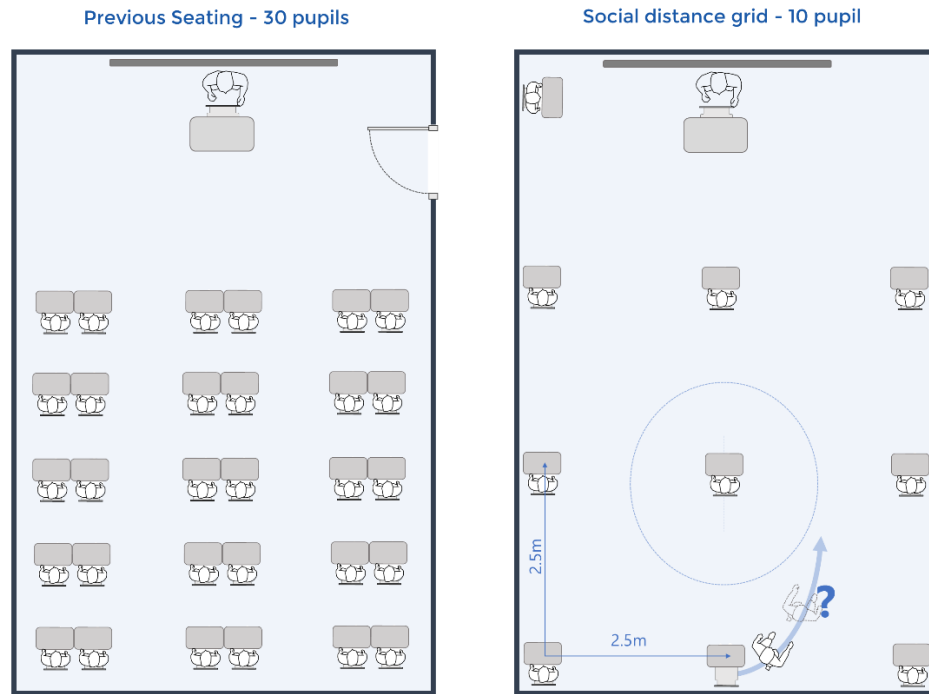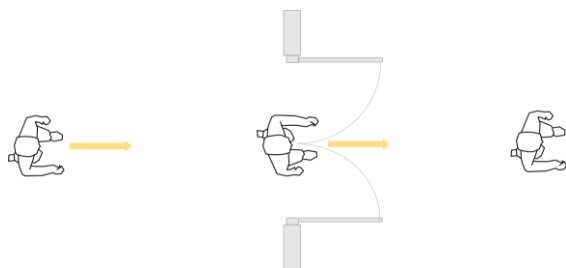
FIGURE 18: showing how a simple grid can ignore the need for circulation.

Don't forget about fire safety

One-way flow through a double door, where doors may still have only 30 people/minute allocated flow rate.

You might be able to split passageways to double the flow to 60 people/min, but this is likely to break multiple codes, and create passages that are too narrow.
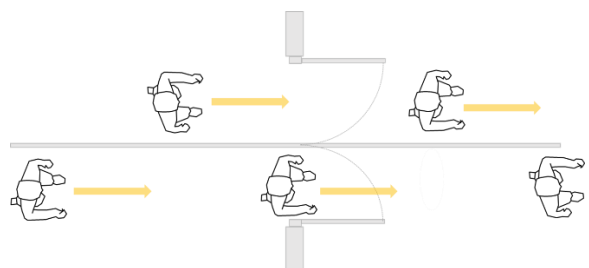

FIGURE 19: A clear breaking of fire safety codes where a door is split in two, too narrowly

You might be tempted to partition corridors or internal doorway openings into two in order to achieve either a doubled one-way flow to two-way flow. It may work geometrically but it is highly

likely to break fire codes and a number of good design principles. Remember you always need to refer back to your applicable fire codes, and check that your new design still works

Also consider that if you change a layout, check that you are not breaking a sealed fire-zone area with designated fire protection ratings.

Using the toolkit in a sample design

Case 1: Layout the route design by leveraging people content, spatial grid and the one way indicator family.
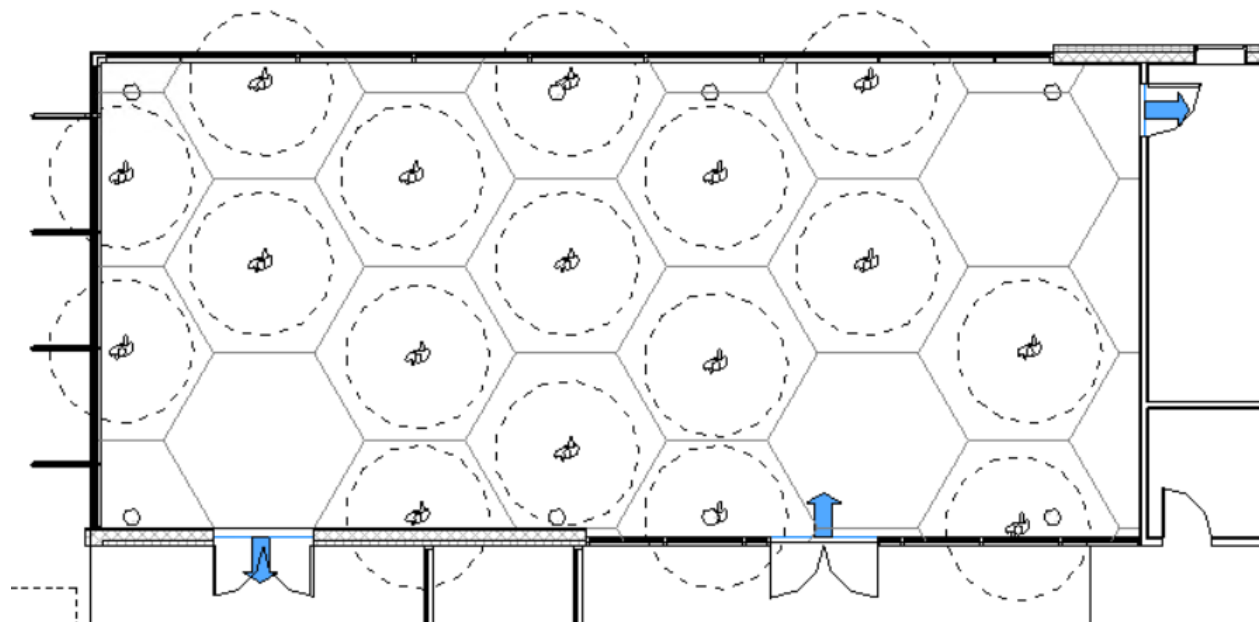

FIGURE 20: showing people content spaces in a hexagonal grid

1. Use a spatial grid to quickly add an overlay on the room to visualize the social distancing requirements.
2. Add multiple people content based on the spatial grid pattern and ensure the layout will satisfy the social distancing and safe evacuation requirements
3. Identify the ingress and egress routes by placing one-way indicator on each door.

Case 2: Design the ingress route based on the extension usage of one way indictor family

1. Embed the one-way indicator family into a new generic model family as shared nested family.
2. To create a bi-directional indictor family, you need to add a mode line as the separation between the two nested one-way indicator families.
3. Place the bi-directional and triple-directional indicator in the project and adjust the length of separations.
4. Using multiple Paths to generate all the alternatives of the ingress routes
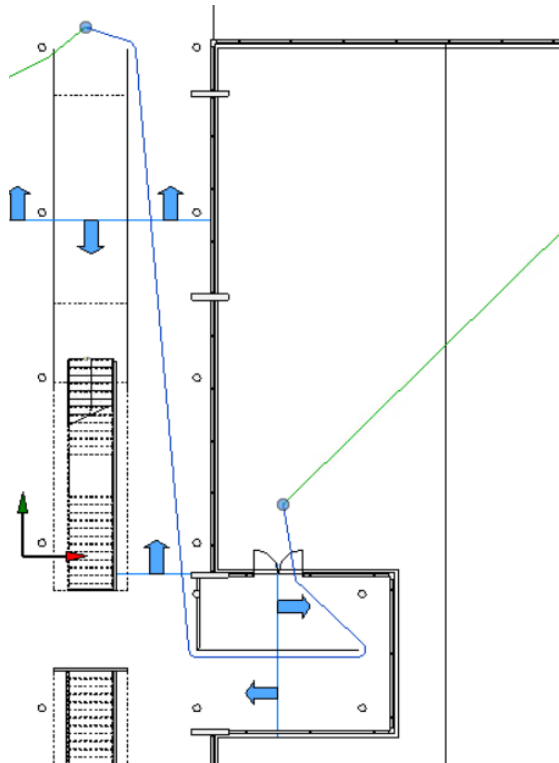
FIGURE 21: showing an ingress route with multiple one-way indicators

Summary

With the People Flow Toolkit, we're expanding functionality to address the challenges of designing for physical distancing due to COVID-19. You should come away from this instructional demonstration today with a few key things to remember:

When designing, keep in mind

- Social distance is "contact distance" in-between people.
- Different grids & partitions are available
- One-way flow is "the new normal"
- Don't forget about fire safety

New tools in the toolkit

- New spatial planning: spatial grids for rooms
- One-way indicator: a shared nested family
- Analyze one-way routes
- Multiple paths: more alternatives
- Available for Revit 2020.2 and 2021

Hopefully, by explaining some of the background of the term "social distancing", with some notes about how to measure it and then how to implement it into your Revit model design, you should be armed with both the knowledge and capability to use these new tools. The application example on a larger design should have helped with some real-world knowledge for the process of using this on proposed designs and the bullet-pointed design principles should act as useful reminder when applying these tools going forward.

Please let us know what you think of the technical preview and we would welcome your feedback on the user forums.